The SCIENCE COUNSELOR

A Quarterly Journal for
Teachers of Science in
the Catholic High Schools

VOLUME IV
NUMBER 3
SEPT., 1938

DUQUESNE
UNIVERSITY
PRESS

The Science Counselor

"FOR BETTER SCIENCE TEACHING"

A QUARTERLY JOURNAL *of teaching methods and scientific information for teachers of science in the Catholic high schools. Published at Duquesne University, Pittsburgh, Pennsylvania, in March, June, September and December by*

THE DUQUESNE UNIVERSITY PRESS

Subscription Price: $1.00 per year; Canada, $1.25. Single copies of issues in the current year, 35c each. Business and Editorial Offices at Duquesne University, 901 Vickroy Street, Pittsburgh, Pa.

Volume IV. SEPTEMBER, 1938 No. 3

CONTENTS

National Science Essay Contest

This early announcement of the 1939 Duquesne University National Science Essay Contest is made so that Catholic high schools everywhere will have an opportunity to give increased thought and preparation to their entries. Each year competition for the first honor grows keener as more and more schools throughout the United States enter the contest, and as the essays submitted continue to improve in quality.

All Catholic high schools which teach any of the sciences are invited to participate by submitting *one* student essay on the assigned topic. In order that the greatest good may result from this competition, it is suggested that the essays entered in the national contest should be selected by means of contests in the individual schools.

Teachers are not to expect individual invitations for their schools. *This is an official invitation to all Catholic high schools to enter this contest.* It is an invitation to *your* school.

The essays submitted in this competition will be judged by members of the faculty of Duquesne University. Form, content, and expression will be considered. A gold medal, for permanent possession, will be

(Continued on Page 94)

Retracing "Euclid's Circle"

• By Sister Helen Sullivan, O.S.B., Ph.D., *(Catholic University)*
CHAIRMAN, DEPARTMENT OF MATHEMATICS, MOUNT ST. SCHOLASTICA COLLEGE, ATCHISON, KANSAS

Do you conduct a mathematics club?

Probably not. But you could.

Here are some thoroughly practical suggestions that come from the experience of an enthusiastic teacher of college students. Some of the ideas and procedures described can be modified with little difficulty to meet the needs of high school pupils.

Mathematics can be made interesting. Why not try this plan?

Although our mathematics club is just finishing its second year of existence, we feel that it has aroused interest and stimulated student activity to such an extent as to merit a published account. Those readers who have had experience in club work, either as sponsors or as members, will be able to appreciate this record of happenings. Those who have not, may be inspired and encouraged to organize a club, and it is hoped that they may derive some little help from this account.

The real reason for organizing a mathematics club was our desire to popularize mathematics. When we assumed the position of instructor we learned that most college freshmen avoided the elementary algebra course almost as they would a contagious disease. Those students who had been counselled by discerning faculty members to sign up for the course did so with much apprehension. They confessed it was because of the hope of thereby "filling a group." They entered the course with the feeling that it was unreasonably difficult, and that the secrets of unknown quantities were attainable only by those few who were exceptionally endowed with a "mathematical sense." Countless times this instructor has been approached with: "Sister, I just know I shall fail in this course." It became evident that the major problem of the instructor was to convince students that the subject is easy (when properly presented). Likewise, she must show that because an individual's grandmother or brother disliked the subject intensely and "couldn't learn it," is no valid reason for her avoiding the course.

Before the idea of a club was presented to the entire group of students (sixty or more) who were enrolled in the various mathematics classes, it was discussed with the more advanced students. These seemed interested and urged that a meeting be called of all students taking courses beyond the freshmen five-hour Algebra course. This embraced those taking Analytic Geometry III and Calculus I. Fourteen responded to this call in early October, 1936. It was made clear to those present that the purpose of the club was to facilitate closer contact between professors and students, and to enable the students to become acquainted with some of the "lighter" phases of mathematics not usually treated in the classroom. Likewise, it was intended to cause the department to grow.

The response was most gratifying, and spirited discussion followed. Among other suggested names that of "Euclid's Circle" seemed most desired and was later adopted. The entire group upheld the idea that scholastic achievements should be the basis for admittance, and insisted that a very intellectual tone pervade all the meetings. In keeping with this idea they were of the unanimous opinion that, unlike other clubs in the college, no refreshments would be served at the regular meetings. It was suggested that each regular meeting be devoted to: (a) some historical phase of mathematics; (b) a discussion or treatise of an unusual extra-class problem; (c) mathematical entertainment such as puzzles, trick problems, etc. At the close of this first meeting a committee was chosen to draft a constitution for the club and submit it for ratification at the next meeting. The constitution as drawn up and approved consisted of the following articles:

ARTICLE ONE

The name of the organization shall be Euclid's Circle.

ARTICLE TWO

The purpose of the Circle is twofold: (1) the broadening and intensifying of the student's interest in and knowledge of mathematics through discussion of problems and topics beyond the scope of the classroom; (2) the development of friendly relations among students and teachers of mathematics.

ARTICLE THREE

During the first year of this organization there shall be no officers except a general chairman and a secretary. These shall be chosen by nomination from the floor and election by majority standing vote. The chairman shall have the power to appoint a temporary chairman for each meeting. Beginning with September, 1937, there shall be a president, vice-president, and a secretary-treasurer. These shall be nominated from the floor and elected by secret ballot with a majority vote. The term of office shall be one year.

ARTICLE FOUR

Only persons are eligible for membership who are members of good standing in some mathematics class and who have completed with a "B" average either Course 2A or 2B as listed in the College Bulletin. Membership shall be revoked from those who fail to maintain a "B" average for two successive periods of four weeks each. Students who have been denied membership because of scholastic standing may be reinstated at the beginning of the second month of the following year provided they make a "B" average in the course that

(Continued on Page 85)

Structure and Development of Ants

● By Reverend John A. Frisch, S.J., Ph.D., (Johns Hopkins University)
DEPARTMENT OF BIOLOGY, CANISIUS COLLEGE, BUFFALO, N. Y.

Father Frisch here begins a most interesting study of Ants, restricting his discussion for the present to their structure and development. In our December number he will publish a second article dealing with their habits and instincts. We consider these articles to be an important contribution in this field.

Teachers of biology and of general science will find in this paper valuable information that will be of great service to them in their teaching. All teachers will find these articles interesting and informative.

●

CLASSIFICATION AND DISTRIBUTION

Ants belong to the family Formicidae of the order Hymenoptera, which order also includes the bees, wasps, gall-flies, sawflies and ichneumon flies. The ants are distinguished from the other members of the order by the possession of a slender, highly mobile pedicel, which consists of the first one or two modified, nodiform abdominal segments. The family Formicidae comprises five subfamilies, Ponirinae, Dorylinae, Myrmicinae, Dolichoderinae, and Camponotinae, embracing in all some 5,000 species, sub-species, and varieties. Its lineage dates back to the early Tertiary and probably much earlier, since some of the Tertiary ants are indistinguishable from living genera.

Ants are found in every land and every clime; only the frozen wastes of the Arctic and the barren tops of mountains are free from them. They are at present the dominant group of insects, and there is every reason to believe that they will remain so for a long time to come. In individuals they outnumber all other terrestrial animals. Their colonies are very stable, one colony I know of having been in existence for over 40 years. Their longevity is unique, workers having been known to live from 4 to 7 years, and queens from 12 to 15 years. Their defensive integument of chitin, their relative freedom from enemies, their omnivorous diet, and their flexible architecture, not restricted to the use of wax or paper as in the case of bees and wasps, are all factors which favor the race greatly in its struggle for survival and further expansion.

ORIGIN AND NATURE OF COMMUNAL LIFE

The origin of the communal life of ants is unknown, but the evidence seems to indicate that the earliest races of ants established small colonies in which collective action was poorly developed, each individual doing its own hunting and fighting. Gradually a higher type of social life developed and individualism was succeeded by cooperative action in building, provisioning and fighting, resulting in larger and more elaborate nests. In time, the more advanced races learned to domesticate aphids to assure themselves of a constant supply of honey-dew, while others established fungus gardens, and still others learned to harvest grains.

COMPOSITION OF THE COLONY

The species are all social and consist of at least three types or castes of individuals, males and fertile females or queens, which are both winged, and sterile females or workers, which are wingless. In many species the workers are further differentiated into major and minor workers, with the addition, in some species, of soldiers, individuals with large heads and formidable mandibles, adapted for fighting.

Ant societies are essentially communities of females. The males take no part in colonial activity; their sole function is to impregnate the young queens during the marriage flight. The queen or queens (many species keep several fertile queens in the nest) bear that title only nominally, since they do not rule the colony but confine their activity to the laying of eggs. The building, provisioning and guarding of the nest is done by the various castes of workers. Workers have been known to become functional queens and it is probable that all workers, if fed abundantly, become able to lay eggs, since they all possess rudimentary ovaries.

Wheeler (1926) explains the marvelous communal life of the ants by the fact that

> "each member is visibly predestined to certain social activities to the exclusion of others, not as in man through the education of some endowment common to all the members of the society, but through the exigencies of structure, fixed at the time of hatching . . . Owing to this pre-established structure and the specialized functions which it implies, ants are able to live in a condition of anarchistic socialism, each individual instinctively fulfilling the demands of social life without 'guide, overseer, or ruler,' as Solomon correctly observed, but not without the imitation and suggestion involved in an appreciation of the activities of its fellows."

This "appreciation of the activities of its fellows" has been clearly demonstrated by Chen (1937). He shows that associated ants work with greater uniformity; that the reaction time of ants is shorter, and the amount of work accomplished by the individual is greater when the ants work in association than when they work in isolation, and that the rapid worker has an accelerating effect and the slow worker has a retarding effect on the work of its partner.

DETAILS OF STRUCTURE

The body is sharply subdivided into head, thorax, pedicel and abdomen. Each division is provided with the usual appendages of insect structure. The entire body and the appendages are encased in a chitinous integument, the chitin being absent only at the points of articulation and in a narrow line between the abdom-

inal segments. The chitin is variously sculptured and covered with a variety of hairs, or pubescence, in the different species.

The head varies greatly in shape in different species and may be circular, elliptical, rectangular or triangular. The mandibles likewise present a variety of structure, from short, broad-faced chisels to long, narrow-bladed swords. They constitute a universal tool and are used in excavating soil or wood, in moulding the walls of the tunnels and chambers, in carrying and cutting up food, in fighting and, in some species, even in leaping by closing them rapidly against hard bodies.

The forelegs are likewise important tools. They are used in scraping together the soil and moulding it into pellets, and they help to pat them down after they have been placed in position on the walls by the mandibles. If the forelegs are removed, the ants can excavate and build only with the greatest difficulty and soon abandon the work.

At the base of the tibia of the forelegs there is a movable, spur-like comb, its fringed concavity opposite a similar concavity, likewise fringed with bristles, on the base of the metatarsus. The ant draws its antennae and legs between these two opposed combs, called the strigil, and thus scrapes off any adhering foreign matter. Since combs become clogged, the ants are equipped with amnochaetae, tufts of long hairs, on the lower surface of the head or on the lower lips, which are drawn through the strigil and clean it, much as we clean a comb by means of a thread.

The members of the Ponerine, Doryline and Myrmicine subfamilies have large and well developed stings. In the other subfamilies, as well as in all males, the sting is vestigial or absent. However, the poison gland, associated with the sting, has been retained in all ants. The poison is injected into the wounds inflicted with the mandibles and, in some species such as the Carpenter ant, can be ejected in a fine stream a distance of several inches. The chemical composition of the poison has received little study, but formic acid is present as a rule only in the poison of the Camponotinae. In a confined space the mere fumes of the poison are fatal to ants.

Only a few of our native species, like the fire-ant of our Southern states (Solenopsis geminata) and the larger harvesting ants of the great plains and the deserts of the Southwest (Pogonomyrmex barbatus and P. occidentalis) have formidable stings.

The tongue is a protrusible, elliptical pad covered with fine transverse ridges. The duct of the salivary gland opens at its base. By means of this tongue the ant rasps off solid food, or laps up liquid food, as well as cleans itself and its fellows. Solid food is not swallowed but is taken into a pouch, the infra-buccal cavity, where its juices are expressed and drawn into the pharynx, while the solid residue is ejected as a cud. From the pharynx the liquid food is drawn into the oesophagus and from there into the crop, which is situated in the anterior part of the abdomen. All these parts of the alimentary canal are lined with chitin, which makes absorption of the food impossible. The crop is, therefore, only a temporary reservoir for the storage of the food. It has been called by Foral the social stomach, since the greater part of its store will be fed by regurgitation to the home-staying ants and to the brood. The crop is succeeded by a remarkable structure, the proventriculus, a bulb-like pump, equipped with valves, which by its expansion draws the liquid food from the crop into itself, and by its contraction forces the food into the stomach proper with which it is connected. In the stomach the chitinous lining is absent and the food is absorbed. The intestine, rectum and anus, which succeed the stomach, are also lined with chitin, so that all absorption takes place in the relatively small stomach.

THE SENSES OF ANTS

Vision: Ants possess two kinds of eyes, the compound eyes, two in number, located on the sides of the head, and the ocelli, three simple eyes, located in the form of a triangle on the forehead. Both kinds of eyes are best developed in the males, less in the females and least in the workers, which in some species lack the ocelli entirely. Thus in Formica pratensis there are 1,200 facets or ommatidia in the compound eyes of the male, 830 in that of the queen and 600 in that of the worker. Exner claims that the compound eye forms a single upright image, each ommatidium contributing a portion of that image, and that the distinctness of the image is determined by the number of ommatidia and the convexity of the eye. Since males always have very large and convex eyes they doubtless are able to see considerable distances, which is to be expected, since they must locate the females during the marriage flight. The vision of the queens and particularly of the workers is very poorly developed. According to Wasmann a resting object, as large as a human finger, is not visible to the worker beyond 2 to 4 inches. I have seen ants stride over a lady-bug, conscious of its presence probably by odor, without seeing it, so that visibility for such small stationary objects is probably limited to ⅛ inch.

Nothing is known definitely about the function of the ocelli, except that they are thought to be used for objects at close range and in dark places.

Ants react to violet colored light but not to red and green; this might indicate color discrimination or merely perception of different degrees of luminosity.

Hearing: Whether ants hear is disputed. Some species among the Ponerinae and Myrmicinae have definite sound-producing structures, called stridulating organs. They consist of two parts: a file composed of extremely fine and parallel ridges situated in the mid-dorsal region of the first gastric segment, and the overlapping pointed edge of the preceding segment or petiole. When

(Continued on Page 92)

A Glimpse into
The Human Side of Mathematics

● By Agnes N. McIntyre
MARYGROVE COLLEGE, DETROIT, MICH.

Here is a little human interest story about the origin of decimal fractions, written by a senior student majoring in mathematics at Marygrove College.

After you have read this paper Simon Stevin will be to you a real person. You will appreciate more fully not only the worth of his invention but, also, the difficulty he encountered in converting people to his easier way of performing a difficult task.

Again we say that mathematics can be made interesting.

●

There are human interest stories in mathematics. In fact, the whole story of the development and growth of mathematics is, in itself, a great human interest story. Man needed mathematics for almost every activity of his daily life, and needed it more and more as the centuries passed and these activities became more complicated. In answer to this very real need of man mathematics was developed.

I am going to tell you the story of how one particular need of man was answered by an obscure but great mathematician named Simon Stevin, through his discovery of decimal fractions. Oddly enough to some, Simon Stevin was a sane, practical business man, not a mad, mathematical genius. In fact, the king of his native country judged him sane enough to appoint him Mint Master and Minister of Finance. In this position he had to deal extensively with numbers and number operations. At that time sexagesimal fractions were widely used by astronomers and business men alike. They are much like our decimal fractions but have denominators which are increasing powers of sixty rather than of ten.

The addition and subtraction of sexagesimal fractions are not too long nor difficult because they are much like the addition and subtraction of denominate numbers. However, multiplication and division of sexagesimal fractions are so lengthy, involved, and tedious that since the day I tried to multiply two sexagesimal fractions together in the way that Simon Stevin had to do, I have been undyingly grateful to him for discovering demical fractions.

To help you realize just how long and involved such a problem is, let me suggest a similar but much easier problem—to multiply 150 hours, 25 minutes, and 10 seconds by 7. First, you would have to multiply 10 seconds by 7, giving 70 seconds, which must be changed to 1 minute and 10 seconds. Then you would multiply 25 minutes by 7 changing the answer, 175 minutes, to 2 hours and 55 minutes and add the additional minute. To complete the problem, multiply 150 hours by 7 and add the 2 hours left over from the minutes. This problem is complicated enough, but imagine how much more complicated multiplying 150 hours, 25 minutes, and 10 seconds by 26 hours, 16 minutes and 21 seconds would be. Even one who was as used to working with these fractions as Simon Stevin was, had a firm conviction that this work was very laborious, for he says, "But as the sweet (the great degree of accuracy achieved in sexagesimal fractions) is never without the bitter, the labor of such computations cannot be disguised, for they involve tedious multiplication and divisions of sexagesimal fractions."[1]

In an effort to devise some easier method of computing with these fractions, Stevin struck on the idea of combining the essential features of sexagesimal fractions with the place value idea of the Hindu-Arabic numerals. Decimal fractions were the result.

It's only human isn't it, to try to find an easier way to do a hard task? Simon Stevin was human, and it was due as much to this quality as to his intellectual genius that he discovered decimal fractions.

After Simon Stevin discovered decimal fractions he had to sell them to a dubious people, at best uninterested, at worst passionately in opposition to his new ideas. There were only a few of the latter but it was the enormous inertia of the former, the common people, which proved the most formidable opposition that Stevin encountered. They did not want to change, because of the colossal adjustments involved and the effort that it would take to make these adjustments. And you can hardly blame them. They did not want to change their units of weights and measures, their whole coinage system and numerous other things involved in applications of demical fractions any more than you would want your whole number system changed, as groups of intelligent mathematicians and scientists are trying to do today. But they are making very slow progress in their attempt to change our number system from a decimal to a duodecimal one, because none of us wants to go through the effort of getting used to a new system, even if it is a better one.

Neither did they. We wouldn't want to learn to count all over again, nor learn the multiplication tables over, nor to learn new units of linear, square and cubic measure; new units of weight, new units of time, a new coinage system—neither did they. That is why

[1]All quotations used throughout this article are taken from the translation of Simon Stevin's work "*La Disme*," given in D. E. Smith, *A Source Book in Mathematics*, New York, McGraw-Hill Book Co., 1929, pp. 20-34.

the task which Simon Stevin undertook, single-handed, was so tremendous; that is why it required a master of human psychology, a very clever business man, and a good teacher to accomplish the task.

The man who was to accomplish this task must first prepare the minds of the people so that they would listen to his new ideas. Then he must give them sound practical reasons why the use of decimal fractions would be more profitable for them than the use of sexagesimal fractions. To complete the task he must present decimal fractions in such a clear, precise way that all could understand and put into practical use this new idea. Simon Stevin accomplished this task in one stroke, by his "La Disme," a treatise on Decimal Fractions.

Stevin's work "La Disme," from which our English word dime or one-tenth comes, is a gem of salesmanship, a masterpiece of persuasion and convincing explanation. In his subtitle he states his biggest argument for the practicality of his invention:

To teach how all Computations that are met in business may be performed by Integers alone without the aid of Fractions.

As a word of explanation,—decimal fractions are of such nature that when computing with them they may be treated as whole numbers. This fact is so commonly used that most of us don't think of decimal fractions as fractions at all. For example, to divide 5.26 by 1.51, we merely move the decimal point two places to the right and divide just as we would if we were asked to divide 526 by 151, with never a thought that we really are dividing 5, a whole number, plus the fraction 26/100 by 1, an integer, plus the fraction 51/100.

Following the subtitle in "La Disme," Stevin addresses separately each class of people whom he wishes to convert to the use of his decimal fractions and sends them his greetings:

To Astrologers, Surveyors, Measurers of Tapestry, Guagers, Stereometers in General, Mint-masters, and to All Merchants Simon Stevin Sends Greeting.

Then to get them into the right mood to receive his new ideas, he flatters them:

A person who contrasts the small size of this book with your greatness, my most honorable sirs to whom it is dedicated, will think my idea absurd, especially if he imagines that the size of this volume bears the same ratio to human ignorance that its usefulness has to men of your outstanding ability.

To remove any resentment that might be harbored in the hearts of his audience, Simon Stevin states very firmly that he is not lauding himself when he praises the usefulness of his invention.

If anyone thinks that, in expounding the usefulness of decimal numbers, I am boasting of my cleverness in devising them, he shows without doubt that he has neither the judgment nor the intelligence to distinguish simple things from difficult, or else that he is jealous of a thing that is for the common good.

However this may be, I shall not fail to mention the usefulness of these numbers even in the face of this man's empty calumny. But, just as the mariner who has found by chance an unknown isle, may declare all its riches to the king, as, for instance, its having beautiful fruits, pleasant plains, precious minerals, etc., without its being imputed to him as conceit; so may I speak freely of the great usefulness of this invention, a usefulness greater than I think any of you anticipates, without constantly priding myself on my achievements.

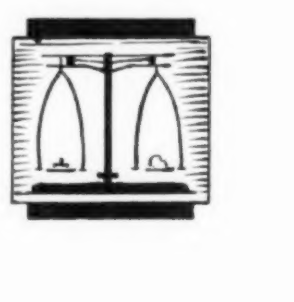
Again Stevin dwells at large on the time saved, the work, the mistakes, and the disputes avoided by using his invention in order to impress upon his readers the practicality of decimal fractions. In his own words,

As your daily experience, Messieurs, makes you sufficiently aware of the usefulness of number, which is the subject of "La Disme," it will not be necessary to say many words with reference to this. The astrologer knows that, by computation, using tables of declinations, the pilot may describe the true latitude and longitude of a place and that by such means every point upon the earth's surface may be located. But as the sweet is never without the bitter, the labor of such computations cannot be disguised, for they involve tedious multiplications and divisions of sexagesimal fractions, degrees, minutes, seconds, thirds, etc. The surveyor knows the great benefit which the world receives from his science by which it avoids many disputes concerning the unknown areas of land. And he who deals in large matters, cannot be ignorant of the tiresome multiplications of rods, feet, and inches the one by the other, which often give rise to error tending to the injury of one of the parties, and to the ruin of the reputation of the surveyor. So too, with mint-masters, merchants, etc., each in his own business. The more important these calculations are, and the more laborious their execution, so much the greater is this discovery of decimal numbers which does away with all these difficulties. To speak briefly, "La Disme" teaches how all computations of the type of the four principles of arithmetic—addition, subtraction, multiplication and division—may be performed by whole numbers with as much ease as in counter-reckoning.

If by these means, time may be saved which would otherwise be lost, if work may be avoided, as well as disputes, mistakes, lawsuits, and other mischances commonly joined thereto, I willingly submit "La Disme" to your consideration. Someone may raise the point that many inventions which seem good at first sight are of no effect when one wishes to use them, and as often happens, new methods good in a few minor cases are worthless in more important ones. No such doubt exists in this instance, for we have shown this method to expert surveyors in Holland and they have abandoned the devices which they have invented to lighten the work of their computations and now use this one to their great satisfaction. The same satisfaction will come to each of you, my most honorable sirs, who will do as they have done.

Following this introduction, the real teaching of the treatise begins. Definitions are given, symbolism carefully explained, operations with these new numbers discussed and applications of this invention to practical work for the astronomer, the measurers of tapestry, the mint-master, the merchants, etc., given.

Through this work of Simon Stevin, many people were converted to the use of decimal fractions. Impressed by their numerous advantages, they have spread the use of decimal fractions so widely that, today, they are in common and almost universal use in our money system, in our metric system, and in every computation of our daily lives.



The Preparation of
Skeletal and Preserved Material for Class Demonstration and Laboratory Study

● By Robert J. Schoffman, C.S.V., M.S., *(University of Illinois)*
DEPARTMENT OF BIOLOGY, ST. VIATOR COLLEGE, BOURBONNAIS, ILLINOIS.

Schools which have limited budgets are fortunate if they have enthusiastic and progressive teachers.

The purchase of skeletal and preserved material for study and demonstration is not always permissible, but excellent specimens can be obtained by the instructor who is not afraid to work and who is willing to experiment a little.

This paper gives detailed directions for the work. It should be helpful to many teachers.

●

To enable students to learn the fundamental facts of life and to appreciate the wonders of nature, biology should be taught in every high school. In order to teach this important subject well it is necessary to have some of nature's architectural materials for class demonstrations and laboratory study. There is no substitute for these natural materials; even the finest models can not show the wonderful workmanship of nature that is manifested in the heart, lungs or other organs of the animal body. Many high schools do not have this necessary material because of the cost, and many instructors are under the impression that they lack the knowledge or time necessary to provide their departments with this material.

The money and materials required for this work can be kept to a very low figure. In most instances material can be obtained free if one is enthusiastic enough to collect it. Odd hours can be employed in preparation, and student assistance can be employed to a great advantage. With a little encouragement, students can be of great assistance. Their interest is stimulated, and their knowledge is increased. Interested students are the most desirable type of students to teach, because their initiative and willingness to work and learn is highly developed. Thus, the preparation of teaching material has the two-fold purpose of increasing the instructor's ability to teach, and of increasing the students' initiative and desire to learn.

It would be impossible to describe the preparation of every kind of skeleton and preserved material in a paper of this type, consequently it will be necessary to limit our discussion to the materials that will be most beneficial to high school classes, and to the simplest means of their preparation.

SKELETAL MATERIAL

The preparation of skeletal material, one of the architectural wonders of nature, is a very simple matter. The essential equipment consists of a scalpel, wire or probe, pan, box of "Gold Dust," and a burner or stove of some sort. The animal material is very easy to get. Cats and dogs may be obtained from dog pounds or from the police departments of any city. Fur-bearing animals such as fox, skunk, mink, opossum or raccoon, may be obtained from fur farms at pelting time, from state conservation departments, or by making trips to the woods and trapping them. Frogs and turtles are very easily caught in the spring and summer in or near ponds and streams. Rendering plants are a source of material for the larger domestic animals, domestic fowl, and brain material. Birds may be obtained by hunting, or from state conservation departments. Student interest and cooperation are a great help in collecting.

After the desired material has been obtained, the preparation is begun. It is a simple procedure. Let us say the skeleton of a cat is desired. This may be obtained by the following steps: (1) Obtain a good specimen, that is, a large and perfectly formed cat old enough that the bones are well hardened and the teeth fully developed. (2) Skin the animal completely. (3) Remove the contents of the abdominal and thoracic cavities. (4) Sever the head from the body at the atlantal occipital joint (the joint between the head and first vertebra). (5) Remove as much muscle as possible, carefully dissecting out the tongue and hyoid bones. The hyoid bones, nine in number, which lie in the muscles of the throat should be dissected out intact. (6) Dismember the limbs, the fore limbs by cutting the muscular attachment, the rear limbs by severing at the hip joint and removing as much muscle tissue as possible. (7) Remove the muscle tissue from the remaining trunk, including the tail. (8) Place each of the six parts, preferably one at a time, in a pan and add sufficient water to completely cover the part. (9) Add about two ounces of Gold Dust. (10) Boil for about three hours until all muscle tissue is detached. Less time may be required if the portions of the muscle are removed as they become loosened. The final cleaning is accomplished by washing each bone under running water with a wire brush and removing any material present in the foramen or openings with a probe or fine wire.

In cleaning the head, boil it until the cartilage at the anterior end of the nose can be removed. The membranes of the nasal cavity can then be removed

by directing a stream of running water through the posterior nares which forces them out through the anterior nasal opening. After the head has been boiled about one hour, the brain can be removed by inserting a stiff wire or probe through the foramen magnum, breaking it up by gentle agitation, and removing the parts by forcing a small stream of water through the foramen magnum. After being thoroughly washed, the bones are laid out to dry. By boiling and cleaning each part separately the bones of that part can be kept together and identified more easily when finished.

Gold Dust acts as a degreasing and bleaching agent. If any grease should remain, it can be removed by placing the bones in xylol, carbon tetrachloride or gasoline for from one to three hours. Upon removal, place them for about five minutes in hot water, to which a small amount of household ammonia has been added. If it is desired to have perfectly white bones, leave them in a 10 per cent solution of hydrogen peroxide for about four hours. Hot chloride of lime can be used on disarticulated preparations such as have just been described. However, if Gold Dust is used, it is seldom necessary to employ additional degreasing or bleaching agents.

If it is desired to have an entire skeleton intact, it is necessary to resort to maceration. Since there is no great added advantage in having such preparations for anything larger than frogs, turtles, or birds, and because of the time and skill required, the process will not be discussed in this paper.

The skeleton of a frog is prepared in a slightly different manner than larger specimens such as the cat, because it is desirable that the bones be held in position by their natural ligaments. The initial steps of skinning and removing of the contents of the body cavities are the same as those previously described. The removal of the flesh must be done with great care so that there will be no destruction of the ligaments which hold the bones together. The fleshed skeleton is then placed between several layers of moist newspapers. The newspapers should be kept damp for several days, permitting mold to form. The mold softens the remaining flesh allowing it to be scraped off easily. When thoroughly clean, degrease and bleach as directed for the cat. A second method of preparation which requires less time but more skill and care, is to immerse the fleshed specimen in boiling water for short periods of time and after each immersion carefully wash under running water using an old tooth brush.

Rat skeletons and those of other small animals are prepared in a similar way.

Mounted skeletons are desirable for museums and certain specialized class demonstrations, but for routine class study disarticulated skeletons are of much more value. Beginners need not feel discouraged if their first attempts at mounting are not very successful.

There are many ways of mounting skeletal material. A satisfactory and simple method is to cut a piece of fiber board the size of the specimen to be mounted and surround it with moulding which can be made of strips of light wood one inch wide and one-fourth of an inch thick. This base is then painted black. The individual bones are mounted in their natural position and fastened by means of wire or glue. It is desirable when mounting larger specimens, such as a cat or dog, to make a saggital section of the head and vertebrae, mounting only one-half of the specimen. The remaining half of the head and vetebrae, along with the ribs and bones of the limbs from one side, can be used for the study of individual bones. Individual bones of the mounted half can be identified by numbers or letters painted on the base board in white. A typed key is fastened to the reverse side.

Small skeletons, such as those of frogs, can be mounted whole in any position desired.

A useful collection of skeletal material showing the different changes that place in the lower and higher vertebrates, consists of the head of a fish, frog, turtle, rodent, marsupial, cat, dog, and bird mounted as previously described. The larger heads should be cut in saggital sections before they are mounted. Similar collections can be prepared to demonstrate the different types of vertebrae and limbs. Many other preparations designed to meet individual requirements can be made in like manner.

The most satisfactory glue for mounting or repairing skeletal material is an acetone and celluloid combination prepared by cutting an old tooth-brush handle into small pieces and dissolving them in acetone. The amount of acetone needed varies according to the consistency desired. As acetone is highly volatile it should be kept in a bottle with a ground glass stopper. The stopper should be kept well greased. From time to time it will be necessary to add additional acetone to replace that which is lost by evaporation when the container is opened for use. This preparation is excellent for repairing broken bones and fastening loose teeth. If white celluloid is used, the color blends with that of the bone. To fasten a loose tooth, wrap the root with a thin layer of cotton, put a generous amount of acetone glue in the alveolus and insert the tooth, wiping away any surplus glue that may be forced out of the alveolus.

PREPARATION OF PRESERVED MATERIAL

Class and laboratory demonstrations of the circulatory, respiratory, and nervous systems are very important, and the material is easily obtained and prepared.

To prepare a demonstration of the circulatory system, obtain a heart from either a horse or cow. When removing the heart from the thoracic cavity be very careful to remove at the same time as large a portion as possible of the vessels that enter and leave the or-

(Continued on Page 88)

An Ornithological Study
Of Pennsylvania

● **By Ralph Thomas**
PUBLIC HIGH SCHOOL, CRAFTON, PA.

Our readers were interested in the provocative article "The Junior Academy of Science," written by the Reverend P. H. Yancey, S.J., which appeared in our June, 1938, issue. We here publish a student paper which illustrates some of the work that is being done by students who belong to such organizations.

Mr. Thomas presented this paper, illustrated by lantern slides, at a recent convention of the Junior Academy of Science of Pennsylvania, held at Bucknell University.

The paper has not been edited.

●

I have chosen for my talk this afternoon the subject of Ornithology, better known to most of us as the zoology of birds, or the study of birds.

In selecting this topic of ornithology for such a brief discussion, I was fully aware that it would be impossible for me to approach even a degree of comprehensiveness over such a field. Therefore, with this in mind, I have selected those sub-topics which I believe will be of paramount interest to you.

How many times, when you have seen or heard a beautiful bird, have you asked yourself the question, "I wonder what kind of bird that is? Why is his song so much more beautiful than that of others I have heard?" Any person has that desire to learn, that desire to increase his knowledge on a subject he comes in contact with daily. His occupation may keep him indoors the better part of his time, but still there is a yearning to go back to nature, to appreciate all that she has to offer. This is surely one of the most wholesome traits of "Human Nature."

It is easy to comprehend the extensiveness of this subject, when one is aware of the fact that there have been recorded in North America 800 distinct species of wild birds, and 400 additional subspecies, or climate varieties. Naturally the individuals of some of these species are far more numerous than are others. For example, during historic times there probably never were more than a few thousand specimens of the California vulture, while such common species as the robin and the mourning dove ran into the millions.

No one state contains all these various forms of bird life. From the latest available information, our native state of Pennsylvania is credited with over 300 distinct species.

Many birds, however, are growing quite rare, and in some cases, are rapidly approaching extinction. A typical example of this is the passenger pigeon. The story tells us that at one time the passenger pigeon was plentiful, but the settlers of the communities along the coast began to kill off all these harmless birds. In a very few years, the bird was no more. It has completely vanished from the face of the earth, and no specimen of its kind will ever be seen again.

The earlier legislative enactments for bird protection in the United States dealt almost entirely with game-birds. So persistently was this class of birds shot, trapped, and netted after the coming of the Europeans, that it soon became apparent that restrictive measures must be taken if some of the more popular game-birds were to be preserved for posterity. These laws at first were amateurish, but as a result of experience they later were established along certain definite lines: first, those setting aside certain seasons of the year when the birds could be killed, this idea being to afford them protection during the period of incubation and caring for the young; second, forbidding certain methods of capture as for example "fire lighting" at night, netting, and shooting into flocks with large swivel guns; and, third, limiting the number that might be taken in a day or season.

It was found that the ordinary civil officers could not, or would not, enforce the game laws satisfactorily; hence there soon developed a plan of employing special state officials known as game wardens, whose special duty it was to see that the laws protecting birds and game were observed. In order to raise funds for the employing of the officers and also to increase the restrictions on gunners, the custom arose of requiring hunter's license fees for all who desire to kill these state assets. This hunting license fund in some of the larger states at times amounts to almost $200,000, or more, annually.

It was not until about the middle eighties that public attention was drawn strongly to the desirability of preserving that group of birds usually referred to as "non-game birds." By a campaign of education the National Association of Audubon Societies, first formed at that time, began to educate the public sentiment on the subject, with the result that the law usually known as the Audubon Law, and which has for its purpose the protection of this large group of birds, has been enacted in the legislatures of all the states but six. On December 10, 1916, a treaty between this country and Great Britain was ratified, extending protection to non-game birds in the Dominion of Canada.

There is today in the United States a very wide interest in the conservation of wild birds. This is manifested in the great interest which the public shows in proposed legislative enactments for bird protection,

(Continued on Page 88)

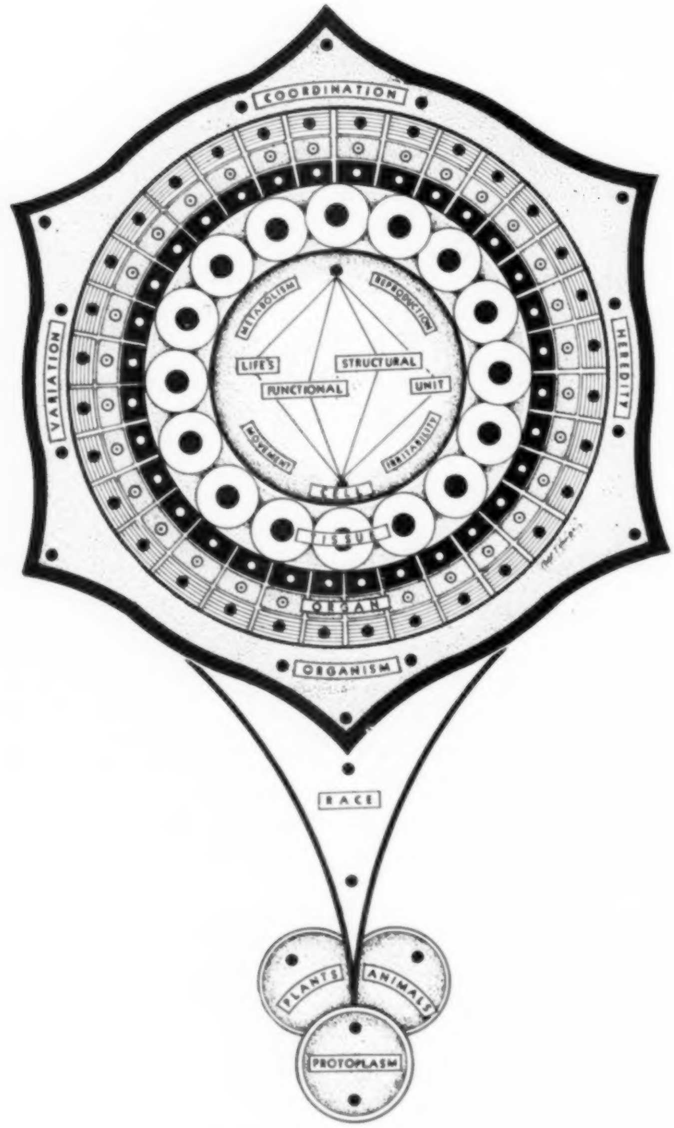


Fig. 1. Protoplasmic Organization

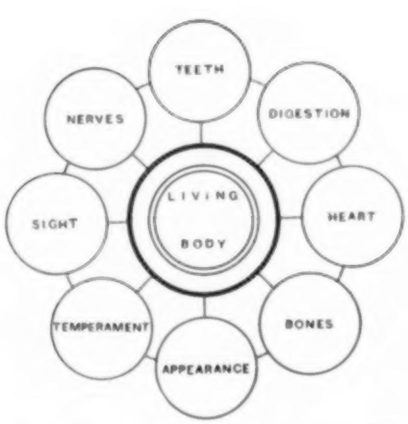


Fig. 2. Teeth in relation to the whole body

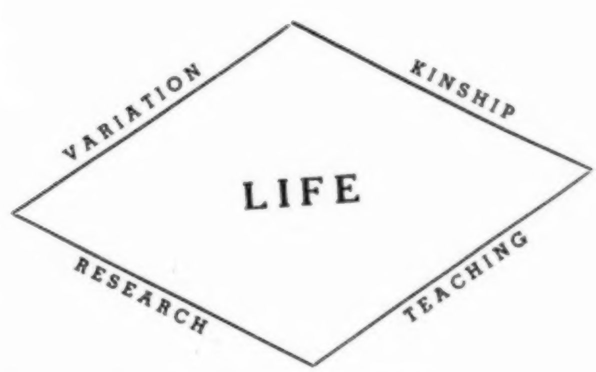


Fig. 3. Biological Education

Dynamic Diagrams

● By Robert T. Hance, Ph.D., *(University of Pennsylvania)*
DEPARTMENT OF BIOLOGY, UNIVERSITY OF PITTSBURGH.

We talk much about the desirability of training students to think rather than to memorize, for we realize that mere memorization is of little value. But often we wonder if we are doing all that we can do to encourage our students to think independently.

In this paper Dr. Hance suggests a method that has been successful in stimulating students to study carefully and analyze and correlate facts, so that they may arrange them into diagrammatic forms that will show relationships at a glance.

Dr. Hance will be remembered as the author of the unusually interesting article "Laboratory Work for the Blind," which appeared in our December, 1935, number.

●

At long last teachers are beginning more generally to believe that the true function of education is to train students to think rather than to memorize. Information is to be used as the material to stimulate these thought processes instead of being emphasized as of prime importance itself. Facts need interpretation and coordination which can only be accomplished by those used to thinking straight, and students so trained have little to fear in facing new situations. They are not limited by specific formulae which may not fit their new problems. They know how to break these down into their fundamental issues which can then be studied for possible inter-relationships, the recognition of which may well lead to the desired solution.

The more general appreciation of this educational goal appeals to me as a happy shift away from the slavish following of textbook material, which procedure, unfortunately, is still all too common even in our colleges and universities. A textbook is a necessary depository of the facts in the field it covers, but if the student is not encouraged to add something of his own to the material by way of organization or of interpretation, the value of the book will remain between the covers.

No biologist, believing in the inherent variability of living substance, will argue that the same sauce will flavor goose and gander alike. Consequently, no one method will equally well lead all students to independent thinking, despite the widely heralded claims for the "plans" of various colleges. We no more learn alike than do we look alike, and for the same biological reasons. Therefore, the present suggestion for encouraging independent thinking by having students formalize their knowledge into diagrams that serve to show, more or less at a glance, the relation of the various phases of the subject will usually appeal only to those who are mechanically inclined.

The production of diagrams that dynamically summarize the essentials of a given body of facts is but one of various ways to train the student in the close study and analysis that is essential to the adequate handling of new problems. Any method that induces the student to work out for himself the relationships between a number of facts contributes to that student's ability to live in a world of changing conditions. No method should become dogmatic or stereotyped through detailed directions by the teacher. When this happens we are back to the difficulties of the factual content between the covers of the textbook, with the teacher reading them to the class.

Diagrams indicating the interrelations of various facts may be drawn with but a few lines and circles, or may be so complicated as to include the principles developed in an entire subject. Examples of simple "dynamic" diagrams are shown in figures 2 and 3, and of the more complex in figures 1 and 4.

Recently a student, after looking at figure 1, remarked in some surprise that it contained all the essential points of the course in histology. The center shows the unit of organic structure, "the cell," in which the chromosomes suggest the hereditary potentialities as well as the basic physiological characteristics of living substance. Outside of the central cell are shown a number of identical cells that represent the make-up of tissues. A variety of tissues, outside of this layer, combine to form the organs. All three unite in producing the organism. The organism goes back to the race, and the race to the original protoplasm that differentiated into the specialized mechanisms of plants and animals.

Figure 4, published here by permission of the Journal of Heredity, and of the 1937 Year Book of the United States Department of Agriculture, shows beautifully the nature of the soil in which genetics has its roots, the materials of the body and the variations of the branches.

Such diagrams mean much to the student who designs them, and serve almost equally well when presented by the instructor to be criticized for accuracy by the student.

Diagrams that represent a mechanical design of interrelations will appeal to many, but it must not be forgotten that they will not be all things to all students. Certain types of modernistic paintings are still referred to as explosions in shingle factories, and it may be equally hard for some to see any resemblance to vital activities when depicted with a ruler and compass.

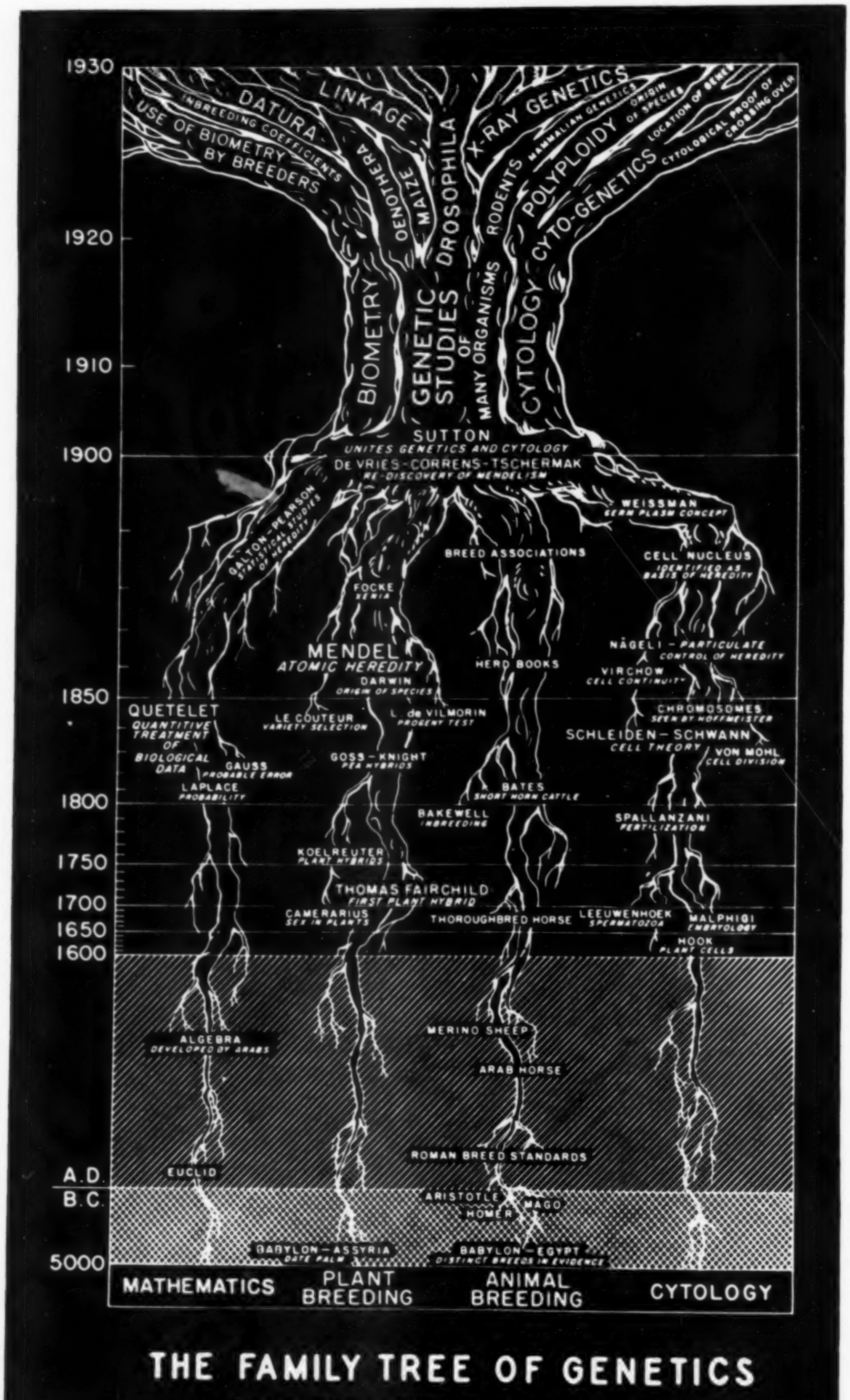


Fig. 4. The Family Tree of Genetics.

The Gardens of the Middle Ages

• By Sister M. Dafrose, O.P., Ph.D., *(Fordham University)*
CHAIRMAN, SCIENCE DEPARTMENT, BISHOP McDONNELL MEMORIAL HIGH SCHOOL, BROOKLYN, N. Y.

In this, the second and concluding part of her study of medieval gardens, Sister Dafrose considers non-monastic gardens, including small gardens, those cultivated by persons of moderate means, the gardens of the rich and noble, and medieval city parks. She describes the simple herb or kitchen gardens and the more elaborate orchards or pleasaunces that were found in connection with castles and towns.

The plans of the various gardens, and the plants, herbs, and trees they contained are discussed. Some of the ornaments used in medieval gardens, such as fountains, lawns, arbours, knots, mazes, labyrinths, and mounts are to be found in modern gardens.

The first part of this paper appeared in our June, 1938, number.

PART II

Non-Monastic Gardens

Perhaps it might be well to open the account of non-monastic gardens with the description of the three types of garden in the "Opus Ruralium Commodorum," written by Petrus de Crescentiis at the close of the thirteenth century. He classified them thus:

"Of small gardens and Herbs

Certain gardens may be made of herbs, some with trees and yet others of both. When consisting only of herbs they require a poor and solid soil, so that they may produce fine plants which greatly please the sight. It is, therefore, needful that the place where such a garden is to be made, should first be freed from noxious plants and large roots which can hardly be done, unless, in the first instance, the roots are dug out, and the place well levelled, and everywhere thoroughly soaked with scalding water, so that the rest of the roots and seeds laying hidden in the ground shall be unable to germinate, and then the whole plot should be filled with fine turf, and the sods themselves thoroughly compressed by wooden mallets and the grass trodden under foot until hardly anything appears, then they will break out little by little and form a green surface. Let the site of the garden be of such a measure as may suit the plants to be permanently grown in it, and it should be planted with fragrant herbs of all kinds, such as rue, sage, basil, marjoram, mint and the like, and similarly all kinds of flowers, such as violet, lily, rose, gladiolus, and the like. Between the level turf and the herbs let there be a higher piece of turf made in the fashion of a seat, suitable for flowers and amenities; the grass in the sun's path should be planted with trees or vines, whose branches will protect the turf with shade, and cast a pleasant refreshing shadow, but in these trees, shade will be more sought for than fruit, and, therefore, they will not need to be dug or manured, which might do harm to the turf. But care must be taken that the trees are not too thick, nor too many in number, which by keeping off air will damage health. A garden needs free air, and superfluous shade breeds impurities; further, the trees are not to be noxious, such as the walnut and some others, but sweet and fragrant in flower and pleasant in shade, such as vines, pears, apples, pomegranates and the like. Behind the turf plot let there be a grent diversity of medicinal and aromatic herbs, which not only please by the odor of their scents but by their variety of flowers rerfesh the sight, among which rice should be mingled in many places for its beauty and greenness, and its bitterness will drive away poisonous animals from the garden. No trees must be planted in the middle of the turf, but that level place shall, rather, boast of free and pure air so that the air shall be healthier and also so that spiders' webs stretched from one branch to another, should not entangle the faces of those passing underneath, as would be the case if trees were planted in the midst. But, if possible, a clear fountain should issue in the middle, because its purity produces much pleasantness. Let the garden be open to the north and also to the east because of the healthiness and purity of the winds. But let it be sheltered against the opposite winds, namely, south and west, on account of their violence, impurity and unsettledness. Although the northwest wind may hinder the fruit, it marvellously preserves the spirits, and health, and will insure pleasure for those who seek that in the garden and not fruit.

Cap. II. *Concerning medium gardens of medium people (of moderate means).*

"According to the means and dignity of their persons, let the space of their garden be set apart, namely two or three or more jugers or ox-ploughs (juger = ⅝ acre); let them be surrounded by ditches and hedges of thorns or roses, and moreover, in warm places make a hedge of pomegranates and in cold places of nuts or plums and quinces. Again, let it be ploughed and raked with hoes or spades, and made flat on all sides. Afterwards, with a cord, let a wide space be marked out, where trees are to be planted in their rows: pears, apples and palms, and in the warm situations, quinces. Again, mulberries, cherries, plums, and such noble trees as figs, nuts, almonds, quinces, and such like, each according to the pleasure of the master. In the rows the trees should be spaced from each other twenty feet for the large and ten feet for the small ones. Between the trees and each row vines may be set of various and pleasant sorts; let them be hoed in the rows, so that the trees and the vines may grow strongly. The whole space cut off from the fields should be constantly weeded from every base and worthless plant. The meadows (lawns) should be mown twice a day, so that they may be more beautiful and permanent. Trees should be planted and shaped, each kind separately. Again, there should be pergolas in the more convenient part made like a house or pavilion.

Cap. III. *Of the Gardens of Kings and Other Illustrious and Rich Lords.*

"Because such barons by reason of their riches and state are quite able to order things in such gardens so as to satisfy their desires, therefore, they for the most part only need labor, and are conscious of the many pleasures which are to be had in this manner.

"Let, therefore, a flat place be chosen, not marshy nor screened from the breath of good winds, and in which springs flow. The spot should be twenty jugers or more, according to the will of the lord and surrounded by convenient and lofty walls. In the north part a grove of trees should be planted, into which the wild creatures placed in the garden may fly and hide. On the south part let a handsome palace be built, to which the King or Queen may resort when they wish to escape from grave thoughts, and to refresh themselves by natural joys and solaces. Let a tempered shade be made for the summer. In the garden a fish-pond should also be made in which diverse kinds of fish may be nourished. Hares, stags, roebucks, rabbits and the like harmless beasts may be put amongst the bushes near the palace, a shelter being made, the roof and walls of which are formed of closely woven boughs.

In this, too, are to be put pheasants, patridges, nightingales, blackbirds, goldfinches, linnets, and all other kinds of singing birds, along the rows of trees which should run from the palace to the grove, but not crosswise, so that whatever the animals do, which are so placed, they may easily be seen from the palace. Also there should be in the garden an erection with walks and bowers made entirely from leafy trees, in which the King and Queen with the barons and lords may sojourn in dry weather. So in this fashion the place would be made pleasant. The whole space beside the walks and walls should be measured out, and fruit trees be planted in places along the walls where you please, which will easily grow, such as cherries, apples, or what is better, willows, abeles, or elms, those which are grafted having stakes, poles and trees, which for many years will increase. The aforesaid (summer) palace may quickly be made of dry wood, and on each side round about vines may be planted to cover the entire edifice; elsewhere may be made arbors of wood or trees, and covered with vines. Further, many delights may be secured by inserting curious grafts on diverse trees, which the diligent gardener may easily discover.

Therefore, it behooves one to know all the kinds of trees and herbs to be placed in such a garden, together or separate one from each other, lest deficiency be found in the plants. In such a garden not only will the King delight himself, but sometimes will ease his necessary cares by glorifying God on high, who is the author and cause of all good pleasure."[31]

These were theoretical divisions of gardens, and give us an overview of what was to be expected in the gardens of various classes of society. The next section of the article purports to show the actual arrangement of non-monastic gardens.

Castle and Town Gardens

Gardens grew as times of peace were prolonged. The monastery was immune from attack even though it lay in a low fertile valley, but for safety's sake the castle had to be set high on a hill. Practically it was a fortress and could spare no space within its wall for a garden except the courtyard. As warfare lessened, gardens were planted outside the walls on the land between the wall and the moat, and finally they crossed the moat and developed into full and unchecked beauty.

During the chaotic disturbed centuries of the early Middle Ages, the burgher dwelt behind the town walls. The houses were built together, so closely, that there was no room for gardens, a vine or fig tree was all that could be planted. There were some temerious gardeners, however, who ventured beyond the town walls and cultivated gardens outside in the open fields. A 14th century book, "Menagier de Paris," described the flower and vegetable gardens of the citizens of Paris, and Fitzstephen in the 12th century declared that London was famous for its town gardens. "On all sides outside the houses there are adjoining gardens with trees both spacious and pleasing to the sight."[22] St. Louis IX, King of France (13th century), laid out a garden on the end of an island in the Seine near Paris and Emperor Frederick (13th century) made a terraced garden supported by arches, similar to the Hanging Gardens of Babylon, at Nuremberg. The Crusaders were fascinated by the size, beauty and magnificence of the gardens they saw in the Levant. Not only did they bring back strange plants like Damask and Provence roses, oleanders, pomegranates and other rare flowering trees and shrubs (St. Louis is said to have brought back to France from the Holy Land the ranunculus—buttercup or king's cup) but they also caught the fever for grafting from the Saracen gardeners who had developed this contribution from the Romans, into a fine art. Grafting was a common practice in Europe in the later years of the Middle Ages. Enriching and enlarging their gardens at home, the nobles enjoyed them by making them outdoor living rooms. Here they held games and tournaments, set up their glistening silk tents, ate their meals, sat on turf benches, or reclined on the flower spangled meadow delighting the eye with its beauty and regaling their ears with the music of the birds and the silvery splash of water in fountains.

Castle and town gardens were of two kinds: *herb or kitchen* gardens and *orchards or pleasaunces.* Before discussing the herb garden of the Middle Ages, a short account of the history of herbs may prove of interest. Herbs or "simples" were used long before the days of written history. Seeds of coriander were found in Egyptian tombs of the 21st dynasty and caraway seeds were discovered among the debris of the Lake Dwellers of Switzerland. Mint, lavender, rue, wormwood, anise, and cumin were mentioned in the Bible, and Theophrastus wrote delightfullly of saffron, crocus and thyme which grew on the hills and along the roadsides of Greece. He gave recipes for making perfumes and cosmetics which contain the same ingredients that are used today. Galen was the first to make cold cream. His writings and those of Dioscorides and Pliny were preserved by the monks who made careful copies in the scriptoria of the monasteries. Herb women gathered the herbs from the woods and fields probably to sell to people who had no herb gardens, but the thrifty housewife grew, dried and stored her own. Mothers, cooks and herb gatherers made a tea of sage for sore throat, of balm leaves to cause sweating, of camomile flowers for indigestion; anise water was used to cleanse the complexion; and oils of lavender, rosemary, etc., were employed for perfumes and for their stimulating and pleasant qualities. Beside their medicinal uses these sweet-smelling herbs were also used to flavor foods, and sometimes to disguise the disagreeable odors of putrefaction. Fragrant oils were burnt and carried through hospitals, not only to counteract unpleasant odors but also for their disinfecting qualities.

Castle Herb Gardens

The herb garden in the restricted grounds of the castle was usually under the direction of the mistress. The women of those days were constantly called upon to care for their sick retainers and for wounded soldiers. They also had to nurse back to health, the Crusaders who returned to their castle homes, ill and exhausted from fevers. The monks and nuns instructed these fair ladies and they seem to have been apt pupils.

Pot herbs like lettuce, cress, scallions, eschalots, carrots, leeks, onions, garlic and turnips were common in the herb gardens of the castle. Many of the herbs grown in the herb or kitchen gardens would be called flowers today. Violets were a common food on the menu. They were chopped up with onions and lettuce for salad, or cooked with fennel and savory for broth. Stewed roses and primroses were a choice dessert. After the Crusaders returned, new vegetables were grown, among them, artichokes, asparagus, horseradish, melons, and tarragon. Gradually strawberries, raspberries and gooseberries were also introduced.

Honeysuckle, lavender, lilies, marigold, poppies, periwinkle, peonies and roses were not only necessary ingredients in compounding medicines but were essential oils in the distillation of flower waters. Both in England and in France, the still room, presided over by the mistress of the castle, was a part of every well equipped castle household.

The herb plot was one of the most important sections in the medieval castle garden. Not only were medicinal herbs and roots grown there, but vegetables that added variety to the menu were raised. Spices that seasoned the meat dishes, flowers whose perfumes

were distilled and rushes that were strewn on the stone floors of the banquet hall were carefully cultivated. Sometimes the rushes themselves were fragrant and some of these, lemon-scented when crushed, may be found even today in the neighborhood of Oxford, probably growing in the very place which at one time supplied many a college hall with its carpet of fresh green.

The herb garden was, however, merely a kitchen garden, not a place to enjoy the open air. The orchard, or pleasaunce, on the other hand, held an important position in the outdoor life of the times and resembled more closely the garden of today. The word orchard was not confined to the place where fruit trees grew but included all kinds of trees and plants. The word orchard is supposed to have been derived from verger, meaning branch.

In its early form, the orchard appeared to have been merely a shady place, turfed to form grass plots planted with forests of cultivated trees. Some plots had no flowers growing among the grass especially when they were used for tournaments or games or exercise. In other instances, the grass plots were bedecked with flowers, forming a "flowery mede" of wild flowers. Later, the gardens, described in the allegorical and other romances, in poems of chivalry and in popular songs, named ornamental and fruit trees, and a certain number of cultivated flowers: the lily, peony, columbine, the gilli-flower, lavender and the carnation among them. Still later the orchard included: (1) a fountain, often of elaborate design, or failing a fountain, a spring-head with a conduit of water; (2) turf-topped seats, though sitting on the grass with or without carpet was a common practice; (3) arbors in the modern sense of the term.

There is a somewhat irreconcilable divergence as to one of the essential conditions of the early orchards. According to some authorities, the center had no obstruction, so that tournaments could readily take place there; others made a central fountain an essential and universal feature that would seem to forbid the holding of tournaments since the limited area of the "meadow" as a whole, left but a small space available around the fountain.

A description of an early orchard was given by St. Albertus Magnus, O.P., who devoted a chapter (De plantatione viridariorum, or the planting of the verger) of his book "De Vegetabilibus," written in the thirteenth century, to the description of the Medieval "Orchard" of that time. "It comprises primarily a grass plot of fine grass carefully weeded and trampled under foot, a true carpet of green turf with no projections on its uniform surface. At one of its extremities, on the south side, are trees such as, pears, apples, pomegranates, laurels, cypress, and others of kinds with climbing vines, whose foliage protects to some extent the turf and furnishes an agreeable and cool shade. Behind the grass plot are planted in quantity aromatic and medicinal herbs; for example, rue, sage and basil, the perfume of which gratifies the sense of smell; also some flowers such as the violet, columbine, lily, rose, iris, and others similar, which, by their diversity, charm the sight and excite admiration.

Finally, at the extremity of the grass in the space reserved for flowers, Albertus recommended that "the earth be raised so as to form a verdant and flowery seat where one could sit and repose."[23]

Another description of an early orchard is given by G. Riat, who developed what he called a "typical Garden of Pleasure" of the early times, by grouping together the various data furnished by literature, archives and art, producing a garden which did not exist, but which was a resume of all the others. He described it thus:

"The garden was usually, especially in the twelfth century, situated outside the ramparts, communicating with the castle by a false postern. Later, there were many examples of gardens of this kind in the courtyards of the seigneurial mansions. A fence, when the garden was in the courtyards, or palisades, when it was outside, surrounded it. A low wall on three sides, provided a back for a grass covered seat and assured privacy for conversation. In a corner was a fountain in the Gothic style, the water disappearing straight into the sol (ground), or serving to water the parterres and the grass plots. Sometimes there was a round flower-bed in the middle of the preaux (pratelli) or flowery parterres. At the sides were arbors and trellis-works fastened to the walls. Sometimes there was a labyrinth, or house of Daedalus, like the labyrinths on the floors of cathedrals.

"Flowers grown in the parterres or in pots along the wall brightened the enclosures. Trees clipped into balls provided shade and gave freshness to the air. The ingenuity of the gardener, like that of the topiarii of ancient Rome, was also exercised in clipping the shrubs, and giving them geometrical forms. Finally, if the space permitted, there was a small basin of water for fish and swans. The supreme luxury was to have an aviary close by, and peacocks strutting about under the eyes of the guests."[24]

The Roman de la Rose opened with the description of the garden, hemmed round with castle wall—a pleasaunce within a fortress—planted with trees from "out of the land of the Saracens and many others, to wit, the graceful birch, the shimmering aspen, the hazel, the oak;" and many flowers withal—"roses and violets and periwinkle, golden king cups and pink-rimmed daisies." There are "channelled brooks" flowing from clear fountains through "thymy herbage and gay flowers." Laid out, with formal pathways and stone curbed borders, with trees cut in various devices, a tunnel or pergola of vines or sweet scented creepers running the length of the wall to form a covered walk for shelter against sunshine or shower, a wooded dell, a flowery slope, and an herb patch, the garden was indeed a pleasant place. There were also labyrinths to provide diversion, aviaries with bright plumaged birds from the East, enclosures for wild beasts, friendly gifts from a neighboring lord, the privy playing place or bower, one of the greatest delights of the garden.

"Here meals were taken and merry pastimes enjoyed as long as daylight lasted. Hither came tumblers and dancing girls and sometimes performing animals. A captive bear would be made to stumble over the rough roads for miles in order to go through its grotesque antics before some joyous company of dames and gallants. But spring and youth was the time to be gay and nothing came amiss to these light-hearted folk."[25]

King James I, of Scotland, imprisoned in Windsor Castle (fourteenth century), weary and woebegone, described the 'herbere green,' which, he said, "to look, it did me good."

"Now there was made fast by the tower wall
A garden fair, and in the corners set
A herbere green, with wands so long and small
Railed all about; and so with trees close set
As all the place, and hawthorn hedges knit
That no one though he were near walking by
Might there within scarce any one espy.

So thick the branches and the leafage green
Beshaded all the alleys that there were,
And 'midst of ev'ry herbere might be seen
The sharp and green sweet-scented juniper,
Growing so fair with branches here and there,
That, as it seemed to any one without,
The branches spread the herbere all about.

And on the slender green-leaved branches sat
The little joyous nightingales, and sang
So loud and clear, the carols consecrat
To faithful love."[26]

Here in the orchard or pleasaunce, the flowers were woven into garlands. Dante, who sums up the spirit of the Middle Ages, from the simplest reality to the sublimest ideals, alluded to garlands and garland making as amongst the joys of the earthly paradise. Boccaccio, in a preamble to one of his tales, related that after dining in the cool shade,

> "The gentlemen walked with the ladies into a goodly garden, making chaplets and nosegays of divers flowers found therein, and singing silently to themselves. In summer, young girls wore no other head-covering save a garland, the knight at the tournament decked his helmet with the chaplet woven by his fair love and many a merry company, wreathed with flowers or foliage, rode forth on May day with trumpets and flutes to celebrate the festival."[27]

Boccaccio also relates, in the third day in the Decameron, that the beautiful company met in the meadow in the centre of the garden reclining on grass so delicate, so dark, that it appeared almost black. Thousands of vari-colored flowers dotted the dark green turf and encircling all, were sturdy green orange and citron trees laden with fruit, providing welcome shade and filling the air with their aromatic perfumes.[28]

Germany, France, Italy had many such beautiful pleasaunces, e.g., at Worms, Paris, and Florence. "The gardens of King Rene at Agners and Aix had open terraces on which grape-vines grew, flanked by exotic aromatic shrubs and beautiful flowers. A running brook, an aviary in which the birds nested in low trees, pergolas and small summer houses beautified the garden."[29]

In Italy, Castellan observed that the gardens retained the ancient distribution of the parts of the buildings: courts surrounded with walks, rooms entering on porticoes without communicating with one another; basins with fountains in the courts; terraces on arcades; oratories in the gardens, all bore a striking analogy to the ancient villa.[30] "Though it is an exaggeration to state that there were no flowers in Italian gardens yet to enjoy and appreciate Italian garden craft it is necessary to remember that it was independent of floriculture."[31]

The oldest non-monastic garden in Spain (fourteenth century) is beside the Moorish palace of Alcazar, near Seville. Arabic in style, it contained walks paved with marble, parterres laid out with evergreens and shaded by orange trees. In many parts of it there were baths supplied by marble fountains from an aqueduct, and there was a contrivance for rendering the walks one continuous fountain by forcing up small streams of water from minute pipes in the joints of the stone slabs on which one stepped, a device which in that hot climate produced a most grateful effect.[32]

Chiavano, at the foot of the Alps on the river Po, was a fairly representative medieval town. Here in the later medieval ages, Crisp says that there were gardens attached to nearly all houses but with the exception of the two monastery gardens and the two castle gardens, they were planted with trees only.[33]

In England, at Woodstock, King Henry I (twelfth century A.D.) had a royal garden. Hentzner described it thus:

> "The palace was encompassed with parks full of deer, delicious gardens, groves ornamented with trellis work, cabinets of verdure (summer houses or seats cut in yew?) and walks so embowered by trees that it seemed to be a place pitched upon by pleasure herself to dwell in, along with health. In the pleasure and artificial gardens were many columns and pyramids of marble, two fountains that spouted water, one round, the other like a pyramid upon which were perched small birds that streamed water out of their bills. In the grove of Diana was a very agreeable fountain with Adaeon turned into a stag as he was sprinkled by the goddess and her nymphs. Here was also another pyramid of marble, full of concealed pipes, which spurted upon all who came within their reach. On the north side was a kitchen garden, very commodious, containing seventy-two fruit trees and encompassed by a wall fourteen feet high. On the west was a wilderness covering ten acres, severed from the little park by a hedge. In the private gardens were pyramids, fountains and basins of marble, one of which was set round with six lilac trees which trees bore no fruit but only flowers with a very pleasant smell. There were also 144 fruit trees, two yews and one juniper. In front of the palace was a bowling green surrounded by a balustrade of greenstone. The whole was surrounded by two woods also enclosed, one 911 acres, the other 671 acres in area."[34]

Fitzstephen, a contemporary of St. Thomas á Becket (twelfth century) wrote that "on all sides outside the houses of the citizens who dwell in the suburbs, there were adjoining gardens planted with trees both spacious and pleasing to the sight."[35]

We have some data on garden management in England. The gardener's salary was about $60 a year. Usually a gardener hired laborers who received from four to twelve cents a day. Women were employed for weeding and watering and were paid four to six cents a day.

Truck gardeners and nurserymen who cultivated extensive gardens to supply the demand for vegetables in cities and plant material for gardens were found in the late medieval period. They had their fruit, flower, and herb markets near St. Paul's churchyard, London, and the "Company of Gardeners of London" was chartered in the reign of King James I.

Area of Medieval Gardens

There was a wide variation in the size of the medieval gardens. It is said that Charlemange received the ambassador of the last pagan King of Spain in an orchard where 15,000 men were able to stand on the carpet in the meadow.[36] The monastery garden of St. Gall was 145 yards square. The garden of the Wartburg in Thuringia occupied about 1,170 square yards. Most of the gardens in the smaller castles were but a few yards

(Continued on Page 96)

Retracing "Euclid's Circle"

(Continued from Page 70)

they are then taking and get a two-thirds vote of the present members.

ARTICLE FIVE

A special meeting shall be called at the beginning of each semester for the admission of new members. The applicants for membership must be recommended by two members of the mathematics club and must receive a two-thirds vote of the club.

ARTICLE SIX

Regular meetings shall be held on the second Monday of every month from 4:00 to 5:00 P. M. A special meeting may be called whenever the faculty adviser deems it necessary.

ARTICLE SEVEN

The Circle shall be supervised by the head of the mathematics department, who will also constitute the "authority" in parliamentary law.

ARTICLE EIGHT

One-third of the membership (or the nearest whole number thereto) shall constitute a quorum.

ARTICLE NINE

The Constitution may be amended whenever sufficient reason presents itself, by a two-thirds vote of the members.

ARTICLE TEN

The Circle shall confine itself to two major social activities annually.

Since a brief summary of the club activities for the year is given later, the remaining portion of this article will be devoted to various details which helped to make our venture a success. It is significant that the selective character of the club was its greatest appeal. It is natural to want to be recognized as a member of a chosen group, or to be regarded as belonging to a superior class. Students in other departments remarked: "I'd like to belong to your club but I just couldn't make the grade." Others said: "It really means something to be a member of Euclid's Circle."

In order to assist the students in the two algebra classes to maintain the "B" average necessary for eligibility at the beginning of the second semester, "honor" assignments were given. These assignments were given out at the same time as the regular daily assignments and each carried a definite "point" value. Thus, in the three-hour algebra course, three "honor" assignments per week were given. These included those very difficult problems and exercises found in every text. Rarely can the average student do them all. Each assignment carried one "point" value, making a total of three "points" per week if the work turned in was entirely correct. Unlike the regular assignment the "honor" work was due at the end of each week (thus giving the instructor a chance to check it over the week end). In this way it was possible for a student to make twelve "honor points" per month, and any student who secured ten out of twelve "points" per month was entitled to an "A" grade. The student who made eight "points" merited a "B" grade, and anything below eight ranked as "C." It was made very clear that daily work *must* be done first; all "honor" work was optional and would be considered only if the student's daily record was complete.

It was astounding what an impetus to activity this system proved to be. It kept each student working at maximum capacity and enabled her to determine her own grade. At times the "honor" assignments required hours of concentrated labor. If complaint was made, the objecting student was told that only the regular assignment was required, and such marks an average or "C" student.

Readers may object to this two-fold assignment idea on the basis that it would require too much book-keeping to record the scores. It works out simply if the daily grades are kept in the daily record book, and the "honor" scores are filed separately. We learned that bibliography cards (3" x 5") which were ruled in four divisions across (one space for each week) and five divisions down (one for each month in the semester) were very convenient. These cards were filed alphabetically. (Of course, the final grade for each month was obtained by averaging the daily work with a weight of two along with the monthly test grade).

It must be confessed that much time is consumed in correcting papers. That is inevitably true for any mathematics teacher, but by insisting on a uniform method of arrangement and carefully written work the labor is greatly minimized. Most colleges have a definite quota of students who, under the provisions of the N. Y. A. Act, do several hours of work daily, acting as secretaries, laboratory assistants or library helpers. Occasionally one meets a student who has had considerable mathematical training. Such a student can do the mechanical work of checking, scoring and recording the grades. The professor need merely glance over the corrected work to make mental note of the errors in order to clear up the difficulties at a subsequent lecture.

It will be noted from Article 4 of the club constitution that only those students are eligible who have attained and maintained the requisite scholastic standing and are taking courses at the time. This provides for a continued interest and makes for a permanency of aim which would be impossible if students were allowed to be club members while not actually enrolled in mathematics classes.

At the beginning of the second semester, sixteen new applicants sought membership, while four students who had been members were dropped from the club list. Two of these were no longer taking mathematics courses, and the other two failed to maintain the necessary scholastic standing.

According to the rules formulated by the charter members, before the applicant seeking admission may be formally inducted into the club, she must receive a two-thirds vote of the existing members. The candidate is then notified of her acceptance and informed

as to the time and place of formal admission. The initiation is dignified and impressive. Each new member is asked to make the pledges known only to the "Sectors." She receives a mathematical name (such as Leibniz, Newton, Euler, etc.) by which she will be known as long as she enjoys membership. The dignity and solemnity which surrounds the initiation ceremony appeals to students and puts them in a very receptive attitude of mind.

One of the club members wrote the words for a club song and adapted them to a standard melody. It was a lively tune and served as a pep prelude to each meeting. The general chairman, an ardent Euclidean enthusiast, devised a club seal and secured club stationery, bearing the seal, to be used for all official communications and formal notices. Ingenuity was shown in the monthly club bulletins which appeared on the college bulletin board. They were mathematical in form and wording and provoked much comment from others in the student body. The announcement of one of the monthly meetings as it appeared on the bulletin board read: "The locus of all students whose major interest is mathematics is the circle of Euclid. Circle will be traced Monday, November ninth at 4 P. M. in Room 101." One club member, of marked dramatic inclinations, cast and revised a play, trained other club members and presented the play in student assembly. It was cleverly done and caused much genuine mathematical enthusiasm.

The club activities fostered deep-seated interest. Most of the members became regular readers of the current mathematical magazines. Formerly the librarian complained that only the instructors used the departmental journals. The various papers, problems and puzzles presented in the meetings caused students to consult the sources. The writer was inexpressibly pleased on numerous occasions to find groups of freshmen absorbed in the *American Mathematical Monthly*, the *Mathematics Teacher*, the *National Mathematics Magazine*, and other periodicals. In several instances some excellent undergraduate research was done. Particular mention must be given to the paper entitled *Classic Problems Solved By Straight Edge, Compasses and the Graduate Ruler*, and to the treatise on *Non-Euclidean Geometry*. Both papers entailed extensive reading and critical study.

Without solicitation, the non-resident students offered the use of their automobiles to transport the club members to the State University in order that they might attend a lecture given by W. D. Reeve, editor of *The Mathematics Teacher*. The two major social activities, the Christmas party and the May picnic, were highly successful and gave ample opportunity for the committees in charge to demonstrate the wide application of mathematics. As a fitting close to the first year's successes these energetic Euclideans kept contacts in the summer months by means of a club "chain letter." One member arranged the course of travel and thus it was sent from member to member, each adding her bit of news. When it finally reached the sponsor at the close of the summer it had traveled across fourteen states and had recorded briefly the doings of twenty-four Euclideans.

It is the secret wish of the writer that this club may be elevated to the dignity of an undergraduate research group or a pro-seminar assembly. This can be achieved only in time, and if present interest prevails it seems likely it will be accomplished.

The following papers were presented at the monthly meetings during the year 1936-37: "Non-Euclidean Geometry"; "Pythagoras and His Philosophy of Numbers"; "Appolonius and the Conic Sections"; "Euclid, the Pioneer Geometer"; "Aristotle's Contribution to Mathematics"; "Galileo, the Mathematician"; "Present Position of Mathematics in Secondary Schools"; "Classic Problems Solved by Straight Edge, Compasses and the Graduate Ruler." The club also presented a number of original plays, songs, trick problems and a number games. The mathematical Christmas party in early December provided unique entertainment for the Euclideans. Club members were hostesses to the mathematics teachers of the city schools at the April meeting. The members attended in a body a lecture given at the University of Kansas in Lawrence by Professor D. D. Reeve, editor of *The Mathematics Teacher*. A May picnic closed the year's activities.

New Catalog

On August 15, Corning Glass Works began distribution of their new "PYREX" brand laboratory catalog LP-18. This catalog is the most comprehensive that Corning has offered. It contains 128 pages, and carries 2,353 individual items, of which over seven hundred are listed for the first time. Some of the features of the new catalog are that practically all ground joints, stoppers, and stopcocks listed are now interchangeable; number of pieces per package reduced on many items; and prices are reduced on more than five hundred items, including centrifuge tubes, condensers, distilling flasks, ground joints and connections, separatory funnels and stopcocks, tubes for clinical laboratories, as well as some generally used sizes of test tubes, tubing, and rod.

An Ornithological Study

(Continued from Page 77)

in the propagation of various game-birds on private and public properties, in the building and erection of innumerable boxes for the convenience of nesting birds, and in the constantly increasing financial support given to the National Association of Audubon Societies and its many affiliated state and local bird protection clubs throughout the country.

A lively curiosity has spread among all classes of thinking people about the names of birds they see, what they feed on, and something of their coming and going, with the result—a growing demand for bird books. No publisher of general literature would today deem his list of books adequate without one or more standard works on some phase of ornithology. Literary magazines constantly are publishing articles on the habits of birds, the migration of birds, the economic value of birds, the aesthetic interest in bird life.

One of the most interesting phases of ornithology is that of bird migration.

The mystery of bird migration has proved a fascinating subject for speculation and study from earliest times. Long ago it was noticed that birds disappeared in fall and reappeared in spring, but, not knowing where they spent the intervening period, many fanciful theories were advanced to account for their disappearance, as hibernation in hollow trees or in the mud of streams or ponds. With later years, however, has come a fuller knowledge of migration, especially of the particular region in which each species passes the cold season, and more definite information in regard to the routes followed in the spring and fall journeys. But fuller knowledge has served to increase rather than to lessen interest in the subject. More persons today are watching birds and noting their times of arrival and departure than ever before.

A knowledge of the times of migration of birds is essential as a basis for intelligent study of their economic relations, and is equally necessary in formulating proper legislation for bird protection—two subjects which form important parts of the work of the United States Biological Survey.

For more than two thousand years the phenomenon of bird migration has been noted, but while the extent and course of the routes traversed have, of late, become better known, no conclusive answer has been found to the question, Why do North American birds migrate?

According to the more commonly accepted theory, ages ago the United States and Canada swarmed with non-migratory bird life, long before the Arctic ice fields advancing south during the glacial era rendered uninhabitable the northern half of the continent. The birds' love of home influenced them to remain near the nesting site until the approaching ice began for the first time to produce a winter—that is, a period of inclement weather which so reduced the food supply as to compel the birds to move or to starve. As the ice approached very gradually, now and then receding, these enforced retreats and absences—at first only a short distance and for a brief time—increased both in distance and in duration until migration became an integral part of the very being of the bird.

As the ice advanced southward, the swing to the north in the spring migration was continually shortened and the fall retreat to a suitable winter home correspondingly lengthened, until during the height of the glacial period birds were, for the most part, confined to Middle and South America. But the habit of migration had been formed, and when the ice receded toward its present position, the birds followed it northward and in time established their present long and diversified migration routes.

I think this discussion has been carried far enough for you to appreciate the sentiment of the well-being of our bird life. The interest in this subject is growing every day; in fact, America is, today, planning new homes for her birds—homes where they may live with unrestricted freedom, where food and lodging in abundance, and of the best, will be supplied, where bathing pools will be at their service, where blossoming trees will welcome them in the spring, and fields of grain in the fall, quiet places where these privileges will bring to the birds much joy and contentment. Throughout this country there should be a concerted effort to convert the cemeteries, city parks, and estates into sanctuaries for the bird-life of this land.

REFERENCES

Birds of America—By T. Gilbert Pearson and John Burroughs.
Bird Lore—Published by The National Association of Audubon Societies. Kermit Roosevelt, President.
The Works of Frank M. Chapman—By Frank M. Chapman.
The Auk—By Dr. Jonathan Dwight, Jr.

Skeletal Material

(Continued from Page 76)

gan. To insure the removal of the pulmonary arteries, cut away a portion of the lungs. The lung tissue can be removed as soon as the specimen is sufficiently hardened. When completely removed there should remain stumps of the following vessels: pulmonary arteries (right and left branches), pulmonary veins (seven or eight in number), aorta, posterior vena cava, and the anterior vena cava with the branching vena ozygos. Tie off all of these vessels except the posterior vena cava which opens into the right atrium and one branch of the pulmonary artery which opens into the left atrium. Then, with an injection pump, 10 per cent formalin is injected into the right half of the heart by means of the posterior vena cava. When distended with formalin, the vessel is tied.

The left half of the heart is then prepared in a similar manner by injecting 10 per cent formalin

EXPERIMENTAL KIT

To The Science Teacher:

A means of demonstrating---spectacularly-
the fundamental properties of light

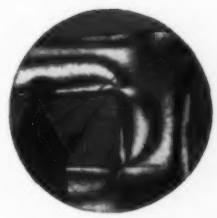
by means of

POLAROID

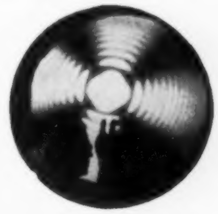
★

Natural crystals against a dark field

Different thicknesses of cellophane



A map of stress distribution in celluoid Models



Interference figures may be projected in giant sizes

Descriptive Literature and Prices on Request

W. J. GILMORE DRUG COMPANY

Laboratory Apparatus Division

422 BOULEVARD OF THE ALLIES PITTSBURGH, PA.

through either branch of the pulmonary artery. The entire heart is then placed in a stone jar or tub and covered with a 20 per cent formalin solution for a week or ten days. If the injection has been properly carried out, the heart will be thoroughly preserved inside and outside and the cavities will be distended, making all the structures visible. As soon as the specimen is hardened it can be removed from the formalin solution and divided into two portions, showing all of the internal cavities and structures. The proper place to section is at right angles to the ventral septum which can be located by paupation. In sectioning, the aorta is divided longitudinally. The two halves can be kept for any length of time in 10 per cent formalin solution.

The respiratory system is demonstrated by removing the lungs, trachea, and larynx of a cow or some other animal in situ. If it is inconvenient to prepare a specimen as large as the lungs of a cow, the lungs of a large dog may be used. However, the larger the lungs the better the demonstration will be. Hardening is accomplished by gently inflating the lungs with air and clamping the trachea with a hemostat or tying. These organs are then gently immersed in a large quantity of 10 per cent formalin solution. It is well to cover the organs with gauze or cotton so that all of the tissue will be submerged. It may be necessary to reinflate the lungs before they are completely hardened. Care must be taken not to destroy the delicate lung tissue by over inflation or rough handling. Be sure to immerse the trachea and larynx in the formalin solution. The tissue is left in formalin solution for forty-eight hours. It is then hung in the open to dry. When thoroughly dry, sections can be cut out like plugging a watermelon, or windows may be cut and hinged with adhesive tape to demonstrate the bronchioles and air sacks. This demonstration can be preserved indefinitely in a cabinet or container that is moth proof.

Brains of sheep are more or less the standard for demonstration and laboratory study. Hence, they will be used for this discussion. Before the brain can be removed, the roof of the cranium, comprising the occipital bone, parietal bones, frontal bones, and squamous temporal bones, is removed by a hand ax with a straight cutting edge, shingling hatchet, or a light cleaver. The first or second attempt may not give perfect results, but in a short time success can be attained. Then only a few minutes will be required to perform the operation. The first step is to remove the head at the atlantal occipital joint. The next step is to skin the head and place it in position. The proper way to hold the head in position is to grasp the muzzle firmly with the left hand, resting the occipital bone and angles of the mandible on a block or solid table. It is necessary to strike several blows to remove the roof of the cranium. These blows should be struck nearly parallel to the frontal bones, that is, with just enough of an angle to allow the instrument to break the bone. The first blow should be struck about mid-way between the nucal crest and the eyes. This is followed by several blows, each of which is anterior to the preceding one, until the entire roof of the cranium is removed, exposing the brain which is covered by the dura mater membrane. The dura mater is removed by careful dissection.

The removal of the brain is accomplished by carefully lifting the medulla forward, cutting the cranial nerves as close to the bone as possible. If the pituitary body is desired, it is necessary to chisel away a small portion of the floor of the cranium in order to remove it intact. The most anterior part of the brain is the olfactory bulbs, the termination of the olfactory nerves, and great care must be taken in dissecting out these parts. A chisel may be employed to make the removal of the olfactory bulbs easier.

The removed brain is hardened and preserved by placing it in a container, the bottom of which is lined with a thick layer of cotton which prevents the soft brain tissue from becoming distorted. It must be covered with a 50 per cent formalin solution because quick and complete hardening is necessary. After hardening for several weeks, the brain can be stored in a 10 or 20 per cent formalin solution.

The brains of small animals as dogs, cats, marsupials or rodents are removed in the above manner. The roof of the cranium is more easily removed however, by means of a small bone saw.

The brains of a horse, cow, pig, sheep, dog, cat, and chicken, placed in glass jars after hardening, make both an interesting museum display and valuable material for studying comparative anatomy.

PRESERVING MATERIAL FOR LABORATORY STUDY

The specimens most commonly used for laboratory study in elementary biology are: the earthworm, grasshopper, crayfish and frog.

Earthworms are easily collected during the spring, summer, and early fall on rainy nights. They are also easily obtained in wooded areas under dead logs or decaying leaves. In a few hours a sufficient number of specimens can be collected to supply an entire class. It is advisable to secure good sized specimens as they are more suitable for dissection. Before preserving, it is well to prepare the worms by placing them in containers with moist filter paper and covering them so as to admit a little air. Place only a few worms in each container, and keep the containers away from direct sunlight, in a cool place, for 24 hours. Then remove any dead specimens, change the filter paper, and allow them to remain for another 3 or 4 days. At the end of this time the dirt will be removed from the alimentary canal and replaced by the paper which the worms have eaten. They are now ready to kill and preserve. Place them in a flat pan containing sufficient water to cover them. During the next two hours add a little alcohol from time to time until the strength of the solution is increased to about 10 per cent. Then wash the mucus from the body of the worms and place them in 10 per cent alcohol until they no longer respond to pinching or pricking. To preserve the worms transfer them to 50 per cent alcohol

for several hours, keeping them as straight as possible, then transfer them to 70 per cent alcohol for 12 hours, then to 95 per cent alcohol for 24 hours, and finally preserve them in 70 per cent alcohol.

Although the alcohol method of preserving is simple and efficient, the chromic acid method is far superior and is well worth the extra time and work. The worms are prepared and killed in the manner described above. Upon removing from the 10 per cent alcohol, however, they are placed in a large flat pan and covered with a 1 per cent solution of chromic acid. While the worms are submerged, they should be kept extended and the acid injected into the body cavity. Two injections should be made, the first about one-half inch posterior to the clitellum, and the second near the posterior end of the body. Care must be taken to inject slowly and not to pierce the alimentary canal. The injection is complete when the worms are turgid along their entire length. The injection is made with a glass syringe of 10 to 20 cc. capacity and a hypodermic needle of either 24 or 26 gauge. At the end of 4 hours (a longer time will make them brittle) remove from the chromic acid and wash in running water until the yellow color is gone (12 to 14 hours). After decolorizing, place them in 50 per cent alcohol for two days, then in 70 per cent alcohol for two days, and preserve in 70 per cent alcohol. While using chromic acid one should protect his hands and arms by rubber gloves or a coating of petrolatum.

Grasshoppers are easily found during the summer months in freshly cut grain or hay fields; they may be captured with an insect net. To kill, place the specimens in a cyanide jar which is prepared by finely grinding about one ounce of potassium cyanide and thoroughly mixing it with about three ounces of plaster of paris. Then add sufficient water to make a coherent mass. Place in a fruit jar and allow to harden. Care must be taken while working with cyanide not to inhale the fumes, and the jar must be closed tightly at all times with a screw cap and rubber jar-ring. The jar should be clearly labeled "poison." Immediately after killing, inject the body cavities with a solution made by mixing equal parts of alcohol and glycerin, and carefully pack in a jar containing this same alcohol and glycerin medium. This mixture provides perfect internal and external preservation and keeps the specimens from becoming brittle. The glass syringe and hypodermic needle previously described are suitable for making the injections.

Crayfish are commonly found in streams, small ponds and swampy or marshy land. They are caught by means of nets, traps, seines, or by a pole and line, using meat for bait. Meat attracts crayfish, and after attaching themselves to the meat, they can be gently removed from the water. A simple and satisfactory way of pre-

serving them is to drop the living specimens into a vessel containing 20 per cent formalin. The formalin on being taken into the body kills and preserves. After the crayfish are killed it is well to remove and carefully straighten them out; then replace in the formalin for storage.

The most important specimen for laboratory study is the frog, which is widely distributed throughout the United States in and around streams, lakes, small ponds, and marshes. They are easily caught by using an ordinary collecting net. Collecting can be done during the day or at night. The best time to make collections, however is at night, using an electric torch or carbide light. A very satisfactory way to prepare frogs with the arteries injected is as follows:

(1) Kill by placing them in a container, such as a battery jar, in which a ball of cotton saturated with ether has been placed. Then tightly cover the container to keep out the air.

(2) Inject the arteries. As soon as the frogs are dead remove them from the container and place them on a table in a dorsal position. (Their backs are on the table with the under or ventral side on the top). Then with a forceps pick up the skin over the pectoral girdle, and with a small scissors remove it, together with enough of the pectoral girdle to expose the heart.

After exposing the heart, the arterial system is injected with a starch mass previously prepared as follows: (Wagner)

Water	100cc.
Glycerin	20cc.
Strong formalin	20cc.
Cornstarch, powdered	75 grams

Mix by gradually adding water and glycerin to the starch, rubbing out all lumps. Strain through cheese-cloth, and add the formalin. If the mass is too thick to strain, add the formalin first. Do not use laundry starch but cornstarch, which is vastly superior. If color is desired, add 10 grams of chrome yellow; for green, 10 grams of chrome green; for red, 10 grams of vermilion.

The exposed ventricle is grasped with the thumb and forefinger of the left hand, and with the right hand the needle (20 gauge) is inserted into the ventricle. The starch mass is injected with a steady moderate pressure which forces it through the arterial trunk into the entire arterial system. To determine when the injection is complete, examine the under surface of the tongue and webs of the feet to see if the superficial arteries contain the colored mass. If necessary, one of the toes of a rear foot can be snipped off to determine if the injection is complete. Yellow color is preferable for beginners, for red often confuses them, giving the wrong impression of the true color and make-up of blood. The presence of color in the arteries enables the student to locate them more easily.

(3) With the same syringe and needle inject 10 per cent formalin under the skin, into the muscles of the limbs and into the body cavity; finally preserve by placing each prepared specimen in a stretched out position, in a glass or stone container and cover with 10 per cent formalin.

Once a museum or collection for laboratory study is started, it will develop with surprising rapidity and repay the effort and time spent in preparation.

BIBLIOGRAPHY

1. Guyer, Michael F., *Animal Micrology*. The Univeristy of Chicago Press, Chicago, Ill., pp. 269-271.
2. Sisson, Septimus, *The Anatomy of the Domestic Animals*. W. B. Saunders Company, Philadelphia, Pa. (1921).

Structure of Ants

(Continued from Page 72)

these two segments move on each other, the edge of the petiole scrapes across the file and produces a very high-pitched sound. It is quite certain that this sound is perceived by the members of the colony.

All ants, even those not possessing stridulating organs, have in their tibia and in other parts of the body, compact, spindle-shaped sensillae, known as chordotonal organs, which are thought to be auditory in function, since they are present in other stridulating insects. It is not surprising, then, that Turner claims that the Camponotine ants, Formica fusca and F. sanguinea, respond to sound vibrations as low as 256 and

as high as 4,138 per second. Most other investigators, however, maintain that the ants do not perceive the sound waves themselves, but rather the vibrations set up by the sound-producing instruments in the substratum on which the ants are resting. Ants are very sensitive to such substrate vibrations. Thus, ants placed at one end of a 10 foot table can perceive the vibrations induced in the table by a pin scratch at the other end. Ants might thus be said to hear through their feet, and in their underground homes it is more important for them to feel the approaching footsteps of a stranger than to hear the sounds of nature or of man.

Tactile and Olfactory: Tactile hairs are scattered over most of the body and legs. They are movably articulated to the chitinous integuments and are supplied with delicate nerve terminations.

The chief tactile and olfactory organs, however, are the antennae. They consist of a single piece, the scape, inserted in a ball-and-socket joint in the sides of the head, but usually extended at right angles to the body, and a funiculus, composed of a number of short joints, 13 in the male and 12 in the female, in our common species. The funiculus is usually held at right angles to the scape, parallel with the body and the antennae are therefore said to be elbowed. Special functions have been assigned to the various joints of the funiculus, but tactile hairs and several types of chemical and olfactory sensillae are equally intermingled on all the joints of the funiculus which makes this specialization doubtful.

Odors of gases and liquids are readily perceived, and it is probably by odor association that ants recognize, not only different species of ants, but also different colonies of their own species and the different castes of their own colony. We, ourselves, can identify certain species of ants by their characteristic odor.

The supreme importance of olfactory sensations in the life of ants, far beyond that of vision, which is useless in their underground homes, is evidenced by the fact that ants, without antennae, cannot excavate, nor locate food, nor care for their young, nor recognize aliens: in other words, they are thoroughly and completely helpless.

Taste: Sensillae are also found on the mouth parts and they probably function in the sense of taste, since ants have their preferences in food. Moreover, ants will begin to eat honey impregnated with morphine or strychnine, which are odorless, but having tasted it, they will refuse it.

Temperature sense: Ants move their brood to the surface galleries in warm weather and to the interior of the nest as the temperature drops. In the dry deserts of western Texas, Wheeler has seen Ischnomyrmex cockerelli "bring its larvae and pupae out onto the large crater of the nest about 9 P.M. and carry them leisurely to and fro, much as human nurses wheel their charges about the city parks in the cool of the evening."

DEVELOPMENT

There are four instars, egg or embryo, larva, semipupa and pupa or nymph. The eggs are usually elongate elliptical in shape and in the largest species are barely 0.5 mm. long. The eggs may be fertilized by the queen with some of the sperm cells stored in her spermatheca, or they may be laid without being fertilized. It is generally stated that unfertilized eggs develop into males, but several investigators maintain that, at least in some species, such as Lasius niger, they may develop into workers.

The larva emerges from the egg as a soft, legless, translucent grub shaped like a "crook-necked squash." The head is small and is provided with mandibles, maxillae and labium. Eyes are lacking. The larvae are usually covered with hairs which probably serve to keep their bodies from direct contact with the ground. In many species the larvae are fed on liquids regurgitated from the crop; in others they are fed on pieces of the solid food brought in by the foragers. The fecal wastes remain in the stomach, where they form a black elliptical mass, since there is, at this stage, no passage between the stomach and the intestine.

The larva, when full grown, becomes a semipupa. In the Ponerinae and most of the Camponotinae it first spins a cocoon, while in the other groups it remains naked. The body becomes straight and rigid, the crook in the neck disappearing. Beneath the cuticle the legs, wings, and head appendages develop and are soon clearly visible, though small and closely applied to the body. The larval skin then ruptures along the back and is stripped down from the body to the caudal end. The small intestine forms an open communication with the stomach and the accumulated fecal mass is voided to the exterior. The semipupa has now become a pupa.

The appendages grow rapidly now and assume their adult form. Though free, they are still folded and applied closely to the body. Pigmentation begins, first in the eyes and then over the rest of the body. The full adult colors are not attained until after development has been completed and the pupa has become active.

The length of time occupied by the several developmental stages is greatly dependent upon temperature. In general, the egg period lasts about twenty days, the larval period about twenty-five, and the pupal period about eighteen.

RELATION TO ENVIRONMENT

As Wheeler states, ants have adapted themselves perfectly to the "earth's great thermal vicissitudes, its droughts and floods and its precarious and fluctuating food supply."

As is the case with all "cold-blooded" animals, low temperatures decrease the activity of ants and, if low enough, immobilize them. Adults, larve and eggs have survived a temperature of 5° C. when thawed out slowly. High temperatures cause discomfort and death. In one experiment the smallest individuals swooned at

35° C. (96° F.) and the most vigorous individuals died in two minutes at 50° C. (122° F.). Lasius latipes has survived submergence in cold water for twenty-seven hours, Camponotus pennsylvanicus for seventy hours, and Aphaenogaster fulva for eight days.

Workers have been known to live without food for seven to nine months. Even such a major catastrophe as beheading has been survived by Formica rufa for nineteen days, and by Camponotus pennsylvanicus for forty-one days; the latter walked about freely to within two days of its death. One of my own workers (Camponotus), accidentally deprived of the entire abdomen, survived and remained active for over a week.

ECONOMIC VALUE OF ANTS

As a group, ants are beneficial and deserve our protection. Their nest-building operations aerate the soil and bring up appreciable quantities of subsoil. They destroy a countless number of harmful insects and, as scavengers, they hasten the decomposition and return to the soil of vast quantities of organic material.

Certain species, such as Lasius americanus, disfigure our lawns with their excavations and might be classed as nuisances.

Other species, which have domesticated and protect plant lice and other insects injurious to plants, are definitely harmful.

The small pavement ant, Tetramorium caespitum, usually has its nest outdoors under stones or flags and invades houses only in search of food.

The very small thief ant, Solenopsis molesta, and the large Carpenter ants may at times invade houses and make their nests in the beams and rafters.

More definitely obnoxious are the habitual house dwellers, the tiny red or yellow Monomorium pharaonis, only about 1/16 of an inch in length, and the equally small black ant, Monomorium munitum, which build their nests in the woodwork and masonry. They are extremely hard to exterminate because of the difficulty of locating their nests.

REFERENCES

Wheeler, W. M., 1926. *Ants, their structure, development and behavior.* Columbia University Press. (Contains an extensive bibliography.)

Chen, S. C., 1937. *Social modification of the activity of ants in nest building.* Phys. Zool. 10 (4), 420-435.

Chen, S. C., 1937. *The leaders and followers among ants in nest building.* Ibid. 437-455.

Science Essay Contest

(Continued from Page 69)

awarded to the writer of the best essay. One or more honorable mentions will be made, depending upon the excellence of the essays submitted. A suitably engraved silver cup will be given to the winning school. The cup will be held for one year. It will then be passed on to the school receiving the new award. This cup is now in the possession of the Bishop McDonnell Memorial High School, Brooklyn, N. Y., the school which won the 1938 contest.

Announcement of the winner will be made at the next annual Conference for teachers of science which will be held at Duquesne University in February, 1939. The prize essay will be published in full in the SCIENCE COUNSELOR. Only winning essays and schools will be announced. A list of the schools which enter the contest will not be published.

Schools which expect to submit essays in this contest should so inform the Director of the Science Conference, Duquesne University, Pittsburgh, Pa., by letter or postcard, on or before January 1, 1939. No obligation is incurred by sending such notice.

The rules which are to govern the contest are here given.

RULES FOR ESSAY CONTEST

Subject of the Essay: *The Microscope and Science.* No other subject may be used.

1. Any student enrolled in a Catholic high school, junior high school, or preparatory school, who has not

yet completed four years of high school work, is eligible to enter this contest. It is not required that the student shall be enrolled at present in any science course. Catholic students attending public high schools may not compete.

2. Each school may submit *only one* essay.

3. Essays should be typewritten, double-spaced, with good margins, on one side of the sheet only. Legible hand-written manuscripts may be accepted. Essays are to be in essay form. They may not exceed 1,200 words in length. Longer essays will be rejected without reading. All direct quotations must be inclosed in quotation marks and references given. Long quotations are not acceptable. Essays may not be illustrated nor accompanied by charts or exhibits.

4. Each essay shall be the individual work of the student. In its final form it may receive only such supervision as is given in the usual written examinations of the school.

5. A plain, sealed envelope, firmly attached to the essay, must contain the full name, age, and home address of the contestant, the actual number of words in the essay, the name and address of the school, and the name and title of the supervising teacher. No further identification of the writer or the school may appear on the essay or the envelope.

6. Essays must be forwarded by the principal or the supervising teacher with the statement that the essay was written under supervision and that it is the original work of the student.

7. Essays for this contest must be mailed to the Director of the Science Conference, Duquesne University, Pittsburgh, Pa., not later than *February 1, 1939.* Essays will not be returned.

SCIENCE PROJECTS

Teachers are always interested in the work done and the teaching methods employed by instructors in other schools. Teachers of science may be greatly aided by studying the student projects that have been found workable and useful by other teachers. An exchange of ideas is helpful and productive of good. Duquesne University, therefore, invites teachers everywhere to select some of the more successful science project material they have used or developed, and submit it for display at the Science Conference in February, 1939.

The projects submitted need not be original; neither need they necessarily be elaborate or expensive. They may be in the form of home-made apparatus, collected materials, herbaria, specimens, displays, teaching devices, models, carvings, drawings, photographic work, special charts, etc. They may be connected with any high school science. Displays at other conferences have included everything from models of teeth carved from soap to home-made telescopes; from a collection of butterflies to a series of instructional charts. Pictures of some of these have appeared in the SCIENCE COUNSELOR. Photographs will be made of the most interesting projects displayed at the coming meeting.

Please send in a display even if you are unable to be in attendance. In order to display your projects it is not necessary that you or any member of your science staff shall attend the Conference. Regardless of where

your school is located, this is an opportunity for *you* to help other teachers of science. *Will you do it?*

Each display should be labeled with the full name and address of the school, the name of the teacher, and the name of the student. They should be addressed to the Director of the Science Conference, Duquesne University, Pittsburgh, Pa., and shipped so that they will arrive on or before February 12, 1939.

All project material will be returned, carriage paid, to the cooperating schools after the Conference.

◆

Gardens of Middle Ages

(Continued from Page 84)

square. In England, a private gentleman's herb garden was about twenty yards square and his fruit garden forty yards square, while those of the nobles were respectively thirty and eighty yards square. Some gardens were so small that a single tree could shade them completely.

Medieval Garden Walls

The medieval garden was a garden enclosed. The outside walls of the *hortus conclusus* were constructed of stone, brick and daub. The inside partitions were made of wattle, palings, rails, lattice work, hedges and in the later centuries of pleached or interwoven branches of trees or shrubs trained into a naturally covered green alley, similar to an arbor but requiring no artificial supports.

Medieval Plants

Charlemagne (742-814 A.D.) was not only a great emperor but also one of the most active and businesslike kingly gardeners. The royal herb garden attached to the palaces at Aix La Chapelle, at Ingolheim on the Rhine, and to his other large estates, were not only a delight to the eye but were also models that he expected monks and nobles to copy. His "Capitulare de Villis," issued 812 A.D., enumerated the herbs grown in the gardens of the period. The modern names, as listed have been identified by Dr. Fischer Benzon:

"Lilium	Lilium candidum	White Lily
Rosa	Rosa Gallica	Rose
Penigrecum	Trigonella-Foenum-Graceum	Fenugreek
Costum	Tanacetum Balsamita	Costmary
Salvia	Salvia officinalis	Sage
Ruta	Ruta graveolens	Rue
Abrotanum	Artemisia Abrotanum	Southernwood
Cucumeres	Cucumis satirus	Cucumber
Pepones	Cucumis Melo	Melon
Cucurbita	Cucurbita Lagenaria	Battle gourd
Fasiolum	Phaseolus vulgaris	Bean
Ciminum	Cuminum Cyminum	Cummin
Rosmarimum	Rosmarinus officinalis	Rosemary

Carcium	Carum Carvi	Caraway
Cicer Stalicum	Cicer arietinum	Chick Pea
Squalla	Scilla maritema	Squill
Gladiolus	Iris germanica or I. florentina	German Iris or Orris
Dragontea	Artemisia Dracumculus or Arum Dracumculus	Dragon Tarragon
Anesum	Pimpimella Anisum	Anise
Coloquentidae	Citrullus Colocynthis	Bitter Apple or Cucumber
Solsequium	Cichorium Sntybus	Chicory
Ameum	Ammi majus	Herb William
Silum	Laserpitium Siler	Laser-wort
Lactuca	Lactuca Scariolavar	Lettuce
Git	Nigella satina	Fennel Flower
Eruca alba	Erucca satira	White Pepper
Nasturtium	Lepidium satirum	Garden Cress
Parduna	Aretium Lappa or Tussilago Potasites	Butter Bur
Puledium	Mentha Pulegium	Penny Royal
Olisatum	Smyrnium Olusatrum	Parsley
Apium	Apium graveolen	Celery
Leuisticum	Ligusticum Levisticum	Lavage
Savina	Juniperus Sabina	Savin
Anetum	Anethum graveolens	Dill
Fenicolum	Anethum Foeniculum	Fennel
Intuba	Cichorium Endivia	Endive
Diptamnus	Origanum Dictamnus or Dictamnus albus	Dittany
Simape	Senapes nigra	Mustard
Satureia	Satureja hortensis	Summer Savoy
Sisimbrium	Mentha aquatica	Water Mint
Menta	Mentha aquaticavar	ditto variety
Mentastrum	Mentha silvestris	Horsemint
Tanazita	Tanacetum vulgara	Tansy
Nepta	Nepeta Cataria	Cat mint
Fibrifugia	Matricaria Parthenium	Feverfew Chrysanthemum
Papaper	Papaver somniferum	Poppy
Beta	Beta vulgaris	Beetroot
Vilgigina	Asarum europeum	Asarabacca
Mismaloae	Althaea officinalis	Marshmallow
Malva	Malva sylvestris or M. nezleeta	Mallow
Carvitae	Daucus Carota	Carrot
Pastinaca	Pastinaca satira	Parsnip
Adripiae	Atriplex hortensis	Orache
Blitae	Amarenthus Blitum	Blite
Ravacaulis	Brassica oleracea var. caulorapa	Kohl Rabi
Caulis	Brassica oleracea	Cabbage
Uniones	Allium cepa	Onion
Britlae	Allium Schoenoprasum	Chives
Porrus	Allium Porrum	Leek
Radices	Raphanes satirus	Radish
Ascalonicae	Allium Cepa var	Variety of Onion
Cepae	Allium Cepa var	Ditto
Alia	Allium Cepa var	Garlic
Warentia	Rubia tinctorum	Madder
Cardones	Cynara Cardunculus or C. Scolgmus	Cardoon
Fabae majores	Vicia Faba	Bean
Pesum Mauresceum	Perium arvense	Field or gray pea
Cariandrum	Coriandrum sativum	Coriander
Cerefolium	Anthriscus Cerefolium	Chervil
Lacteridae	Euphorbia Lathgris	Wild Caper
Sclarea	Salvia Sclarea	Clary
Jovis barba	Sempervivium tectorium	Houseleek"

The trees listed by Charlemagne were: Apple, pear, plum, service tree, medlar, chestnut, peaches, quinces, hazelnut, almond, mulberry, bay, stone, pine, fig, walnut, cherries; the shrubs included bay, box, cypress, laurel, privet, thorn, yew.

The herbs named for the kitchen garden and the physic garden in the monastery of St. Gall were:

Kitchen Garden Herbs

"Onions	coriander	radishes
garlics	chervil	parsnips
leeks	dill	carrots
shallots	lettuce	cabbages
celery	poppy	beet
parsley	savoy	corncockle

Physic Garden Herbs

Peppermint	cornflag	lavage
rosemary	penny royal	fennel
white lily	fenugreek	tansy
sage	rose	kidney beans
rue	watercress radish	savoy"[37]
	cummin	

The "Herbarium" of Apuleius, existing in manuscript form for many centuries, and finally brought out as a book in the fifteenth century, listed hundreds of herbs. The "Leech Book of Bald," the manual of a Saxon doctor, listed four hundred herbs, and Macer's "Herbal," naming several hundred herbs and describing their cultivation, was consulted by gardeners in the twelfth century. The Benedictine Abbess, St. Hildegarde (d. 1179) in her "Physica" enumerated several hundred plants and nearly one hundred trees.[38] About the middle of the thirteenth century, an Englishman, Bartholomaeus Anglicus, a Minorite Friar, wrote "De Proprietatibus Rerum," and devoted the seventeenth book to herbs. His botanical and medical heritage is traceable to Aristotle, Dioscorides and Galen, but he also knew his herbs well, and was a practical herb gardener. In 1398, John de Tervisa, chaplain to Lord Berkeley, translated the book into English. The first German herbal, "Herbarium Vivae Eicones," was composed by Otto Brunfels of Mayence, a Carthusian monk who later became a follower of Luther. It is no exaggeration to state that the monks carried all the garnered herbal knowledge of the Greeks and the Romans down through the centuries, applied it practically, kept many species of herbs in cultivation and taught their neighbors how to raise and use herbs.

Of the plants listed by Charlemagne in 812 A.D., there are only two—the rose and the lily—that are classified as flowers today. The interest in flowers, as flowers, brought about two changes. *First*, whereas in early medieval centuries flowers were grown together with vegetables and herbs, the later centuries saw them separated, since it was considered bad taste to force the company of the lowly onion on the regal rose. As we have seen, the making of nosegays and garlands grew to be one of the pleasant duties of the housewife and for these she had her special beds of roses, lilies, peonies, pinks, marigold, violets and periwinkle. Here she collected her seed and exchanged it with her neighbors in the manner common to lovers of flowers the world over.

Second, as flowers increased in popularity, interest in herbs declined, or rather herbs were relegated to the realm of science and made subjects for botanical gardens. The original purpose of these botanical gardens was to protect doctors and apothecaries against ignorant and unscrupulous drug sellers and root diggers. Logically, these botanical gardens were connected with universities which conducted Schools of Medicine. As a matter of fact, botany and medicine were taught by the same professor for many a year. The botanical gardens were frequently used as classrooms. From this humble origin, as a garden of medicinal herbs, an expansion to include plants brought in by exploration and commerce was soon made. The first of these botanical gardens is claimed by Hamburg in 1316 A.D. Salerno had one about 1340 A.D. and Venice in 1533 A.D. These were all under private membership. Louden said that "the first public botanical garden established in Europe appeared to have been that of Pisa begun in 1544 by Cosimo de Medici, and Ghino and Caesalpino, celebrated botanists, were alternately its directors. Belon, a French naturalist, who was at Pisa in 1555 A.D., was astonished at the beauty of the garden, the quantity of plants it contained and the care taken to make them prosper."[39] Wright maintained that it was when Prospero Alpinus (1553-1617 A.D.) became professor of botany at the University of Padua in which a "Chair of Simples," the first of its kind in Europe, had been founded in 1533 A.D., at the suggestion of Francesco Bonapede, that the first Botanical Garden for public study, the forerunner of the long list of institutions for research in botany was founded.[40] The Botanical Gardens today maintain a research laboratory, a library, a herbarium, and a large collection of plants growing both outdoors and in greenhouses. Here research workers study the relation of horticulture to practical affairs in any phase of plant life.[41]

Medieval Garden Ornaments

The *fountain* held an honored place in the medieval garden whether it was "one that sprinkleth or spouteth water" or "a fair receptacle of water, some thirty or forty foot" or "a bathing pool, shallow, approached by steps," or "merely a large sized tub."[42] To water the garden, the bathing pool or fountain basin, at first served for a dipping well. Later an extra cistern was provided or a tub was kept in a corner and wheeled out. A pump was attached to the tube and sprayed water over the plants. Sometimes dirt canals were provided around the beds to lead in tiny rivulets to irrigate the plots.

The *lawn*, close clipped and rolled, familiar to us today, rarely found a place in a medieval garden. It was "tall grass of deepest green," reported Boccaccio, "starred with a thousand various flowers."[43] Here on this soft sweet smelling grass, the lords and ladies sat. Domestic accounts of the period show that the only method adopted for keeping the grass plot in order was to returf it every three or four years, the constant cutting and other attention of modern times being apparently unknown. For those who did not care to sit on the grass, seats were provided in the form of fixed turf benches, eighteen inches to twenty-four inches high and equally wide, set against the walls or around the trees. Frequently these were supported by planks, or bricks of wattles and provided a fairly comfortable seat. Chaucer in "The Flower and the Leafe" described them thus:

> "And so I followed, till it me brought
> To a right pleasant arbour well wrought
> That benched was and with turfes new
> Fresh turved, whereof the green grass
> So small, so thick, so short, so fresh of hew
> That most like unto green wool thot I it was."[44]

The *herbere* or *arbour* was another garden ornament that grew both in size and design during medieval times.

Beginning as an extension of the walled fence that inclosed the early circular gardens and of the poles used to shade the turf seats, it developed into a bower of woven wattles over which vines and roses were trained. Not only did this provide welcome shade but it also formed a "private playing space," a private meeting place, a favorite spot for romance and intrigue. We find it in Guillaume de Loris, "Roman de la Rose," in the "Lays" of Marie de France, in Chaucer's "Parlement of Fowles." In the course of the centuries it grew into a green tunnel or gallery that surrounded the garden on three, or even on four sides and so covered the cross paths that it divided the garden into four parts.

Knots were distinctly medieval in their origin. In 1502, A.D., the Duke of Buckingham's accounts show a payment for "making knots in the Duke's Garden." In the same year "clippin of Knottes" is recorded in the Earl of Northumberland's Garden, and by 1520 most English Gardens had some kind of novel knotted bed. The style originated in Italy, passed to Flanders, to France and finally to England. Here the knots repeated an architectural detail of the house and eventually formed elaborate embroidered parterres. Knots were of two kinds, open and closed. Open knots had the design set out in lines of box, rosemary, hyssop, thyme, or other plants that were low growing or could be clipped. The design might be merely geometrical, in complicated as well as in simple forms, or laid out to show beasts, birds and heraldic and other forms. The intervening spaces were filled in with different colored earths, with bones of sheep, or with round whitish or bluish pebbles or stones and the paths, when not of grass, were covered with loose sand.

The *maze*, a low planting, and the *labyrinth*, a high planting "well framed to a man's height" were two other medieval garden ornaments. The terms labyrinth and maze were almost constantly used as synonymous terms. "Labyrinth," however, was more properly applicable to arrangements which were simply a question of length. The term maze was more properly applicable to those arrangements which had a block at various points which obliged the visitor to retrace his steps. There was scarcely a design for a garden given by De Cerceau in his "Architecture" (ca. 1250 A.D.) in which there was not a round and a square labyrinth Mazes were square, triangular, star-shaped or worked out in an intricate and unusual manner. At first the divisions of the maze were low, later they were raised to three and four feet and later still they were made much higher.[45]

Parterres were chiefly of four kinds:

Parterres of embroidery in which lines of box with which they were planted imitated embroidered work;

Compartiment parterres in which the design was reversed and doubled so that it was symmetrically repeated four times, at top, bottom, and sides;

English parterres in which the grass plots were of a piece, or cut into several pieces, by sanded intersecting paths;

Cut work parterres which had no grass or embroidery but had the space cut into beds of regular geometric shapes with raised box edges. They were planted entirely with flowers and shrubs regularly placed.[46]

Topiary work, a heritage from the Romans, was commonly used and elaborated. At first the hedges were merely clipped to square corners, then they were sculptured into all manner of elaborate shapes to lend diversity and interest especially to knot gardens. The shrubs and bushes were shaped into mushrooms, rings, balls, peacocks, representations of birds and beasts, lions, crowns, dates, family coats-of-arms and even into the shape of men or women. Meyer describes a huge rose-tree that was trimmed and extended over a large hoop to such an extent that twelve knights could stand below its umbrella-like shade.[47] Fruit trees especially, were shaped to decorative figures, and the gardens outside Dresden have preserved examples of these shaped fruit trees down to our own day.

The *mount*, also a Roman heritage, consisted of a heap of earth in the middle of the garden on which was placed a summer house commanding a view of the entire garden. The paths approaching it, the planting of the slopes, the pavilion at the top all were elaborately decorated. The quaint custom of building a platform high in the branches of the trees in imitation of the Persians was also frequently found. Bird cages hung on trees were common in large gardens.

Later medieval gardens also provided space for games and sports. In England, the *bowling green* and archery tournament field were common features. While the men played games, the women wove garlands and sang and danced. Menagier de Paris wrote to his wife: "Know that it doth not displease but rather pleases me that you should have roses to grow and violets to care for and that you should make chaplets and dance and sing."[48] Beautiful silk, or cloth of gold tents were set up in the orchard and here the knights and their fair ladies whiled away many a pleasant hour in song and feasting.

Medieval City Parks

In conclusion it may be noted that a form of civic consciousness developed during the Middle Ages, destined to leave its mark of beauty on many a town and city and to set an example for future generations. Both Greece and Rome had satisfied the desires of the people by setting up city parks. With the increased area and the crowding of population in medieval towns, the people fairly cried aloud for breathing spaces. Tuscan towns laid out tree-lined promenades and many a Spanish townsman strolled through a beautiful alameda. Paris had its public park in the heart of the town, at St. Germain des Pres. This "pratum commune" has left its name in many cities on the continent of Europe, e.g., the Via del Prato in Florence, the Prado in Madrid, the Prater in Vienna. These medieval city parks were another landmark in the evolution of the public park whose history extended from the gardens of wealthy Persians into which the public were admitted to the extensive cross country parkway systems, the elongated parks, which automobile traffic is developing here in the United States.

The development of the beautiful was the end of gardening as of all fine arts. The medieval gardener sought to attain this by a studied and elegant regularity of design in his gardens. The modern gardener seeks to exhibit in his gardens a highly graceful or picturesque epitome of natural beauty. He softens, refines and renders more spirited and striking every natural aspect of growing plants. However, the appreciation of the natural beauty with which God decks the earth and the enjoyment of the seasonal panorama in gardens, the greatest refreshment to the spirits of man, is common to gardeners of both periods.

BIBLIOGRAPHY

20. Schwertner, T., *St. Albert the Great*, p. 44.
21. Crisp, Sir F., *op. cit.*, pp. 15-18.
22. Amherst, A., *op. cit.*, p. 37.
23. Crisp, Sir F., *op. cit.*, Vol. I., p. 26.
24. Crisp, Sir F., *op. cit.*, p. 31.
25. Kemp-Welch, A., *Of Six Medieval Women, Medieval Garden Note*, p. 183.
26. Kemp-Welch, A., *op. cit.*, p. 184.
27. *Ibid.*, p. 187.
28. Griebach, A., *Der Garten*, p. 4.
29. Meyer, F. S., *Gartentechnik u. Gartenkunst*, p. 9.
30. Louden, J. C., *Encyclopedia of Gardening*, p. 72.
31. Wharton, E., *Italian Villas and their Gardens*, p. 16.
32. Louden, J. S., *op. cit.*, p. 215.
33. Crisp, Sir F., *op. cit.*, p. 100.
34. Johnson, G. W., *History of English Gardens*, p. 59.
35. Amherst, A. A., *op. cit.*, p. 37.
36. Crisp, Sir F., *op. cit.*, p. 30.
37. Crisp, Sir F., *op. cit.*, pp. 37-40.
38. Crisp, Sir F., *op. cit.*, p. 95.
39. Louden, J. C., *op. cit.*, p. 42.
40. Wright, R., *Story of Gardening*, p. 109.
41. Gager, C. Stuart, *Botanic Gardens of the World*, p. 149.
42. Wright, R., *op. cit.*, p. 108.
43. Wright, R., *op. cit.*, p. 109.
44. Wright, R., *Ibid.*, p. 109.
45. Johnson, G. W., *op. cit.*, p. 40.
46. Crisp, Sir F., *op. cit.*, p. 115.
47. Meyer, F. S., *op. cit.*, p. 8.
48. Crisp, Sir F., *op. cit.*, p. 115.

Science Association

Twenty-three high schools of the Chicago district were represented at a meeting held at the De La Salle Institute, Chicago, which resulted in the organization of the Chicago Catholic Science Teachers Association. A constitution and by-laws were adopted, and the following officers were elected: President, Brother H. Charles, F.S.C., St. Mary's College, Winona, Minn.; Vice President, Sister M. Fabian, O. P., Visitation High School, Chicago; Secretary-Treasurer, Brother L. George, F.S.C., De La Salle Institute.

The Association aims to promote the best methods of teaching science in the Catholic high schools by a free discussion of various problems of subject matter and presentation. Membership is restricted to "those religious teachers of the Chicago area who are interested in the teaching of science."

Our schools need more organizations of this type.

Printed by Duquesne University Press